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A Revision of the Burrowing Spiders of the Genus Geolycosa (Araneae, Lycosidae)[1]

H. K. Wallace

The spiders included here in the genus *Geolycosa* are sixteen species which may be distinguished from all other wolf spiders by their burrowing habits and genitalia. Many wolf spiders *(Lycosidae)* dig and live in burrows, but only the species of *Geolycosa* spend practically their whole existence in a burrow and possess the unique burrowing habits described below. The females almost never leave their burrows except momentarily to pounce upon their prey; young males behave similarly until after the last moult, when as adults they abandon the burrow to search for a mate. Having once abandoned the burrow the males appear to lack a stimulus to return to old habits and they soon disappear. As soon as the young are old enough to shift for themselves they leave their mother and her burrow, soon settle down, and dig a tiny home of their own which they enlarge, from time to time, to fit their needs.

The burrows of these spiders are quite characteristic in construction; their more-or-less straight, vertical tubes with a slight enlargement at the bottom differ from all other burrows with which I am acquainted. Frequently they occur in loose, sandy soil, and the upper part of the burrow is lined with silk to prevent cave-ins. Many species of *Geolycosa* construct a "turret" at the entrance of the burrow—a small, collar-like structure fabricated from leaves, twigs, sand, and other kinds of debris fastened together with silk. In the absence of a turret a low ring of silk is found in its stead. The turrets and burrows of a number of the eastern species have been described and figured by Treat, Hancock, McCook, and others.

Many wolf spiders besides *Geolycosa* dig burrows, but their retreats can be distinguished, almost invariably, from those made by members of this genus. One of the species which, in burrowing habits, most closely approaches *Geolycosa* is *Lycosa carolinensis* Walck., which frequently digs a hole and builds a turret. The turret cannot always be told from that of a *Geolycosa*, but the burrow almost invariably soon turns at a sharp angle instead of continuing vertically as with *Geolycosa*. *L. carolinensis* leaves its burrow and wanders around on the ground in search of prey, and this is true of all the other burrowing Lycosids with which I am familiar, except *Geolycosa*.

[1] A contribution from the Department of Biology, University of Florida, Gainesville, Florida.

Besides their unique burrowing habits and hermit-like existence, certain morphological features common to the group set these spiders apart from the other members of the family *Lycosidae*. These are (1) genitalia which conform to a common structural plan and bear evidence of a relationship closer to each other than to the other *Lycosidae*, (2) unusually large chelicerae and relatively high head region, particularly in females, (3) distinctive color markings of the legs, particularly of legs I and II, and (4) unusual development of the forelegs in length and stoutness.

The best morphological evidence of relationship lies in the genitalia, both between species and for the group as a whole in relation to the rest of the family. The other characteristics given are not peculiar to *Geolycosa*, are subject to considerable sexual dimorphism, and have not been relied upon in determining relationships. The second and fourth of the characteristics given are no doubt correlated with the burrowing habit.

Species Relationships

On the basis of the characters found in the genitalia the species may be separated into several groups. (1) The first, and largest, of these groupings may be characterized as follows: Median apophysis curved, large; epigynum relatively long, with wide furrows and transverse part of the guide narrow. *Rogersi, missouriensis, fatifera, riograndae, uinticolens,* and *latifrons* belong here. Each of the remaining groups, with one exception, consists of two or three species which are closely related, but I have been unable to determine satisfactorily the relationships of one group to another. It is difficult to describe the slight differences of the genitalia upon which these separations and groupings are based; they can best be appreciated by studying the figures. These rmaining groups are: (2) *turricola* and *hubbelli*, (3) *pikei* and *patellonigra; wrightii* may also belong here, (4) *ornatipes* and *escambiensis*, (5) *micanopy*.

Although the ventral color pattern is useful, in conjunction with the genitalia, in distinguishing between the species, it apparently cannot be used to demonstrate phylogenetic relationships except between the most closely allied forms, which in every case occupy adjacent or contiguous ranges. In some instances two species occurring together in the same environment resemble one another very closely in coloration *(hubbelli* and *micanopy)*, although their genitalia show that they are members of distinct groups; in other cases distantly related species occurring in widely separated areas may have very similar patterns. This is probably due to the fact that the color pattern has changed in relation to ecological and climatic factors (through natural selection) rather than along orthogenetic lines, as is more probably the case with the genitalia.

In group 1, *rogersi* forms a highly distinctive unit, strongly segregated from the remaining species by its peculiar coloration and characteristic features of the genitalia, particularly in the male. Although it is the most aberrant species in the genus, its relationships to the other forms placed in group 1 are so clearly evident that erection of a separate group for its recep-

tion would not be warranted. The remaining species of the group—*uinticolens, missouriensis, latifrons, riograndae,* and *fatifera*—are much more closely related to one another, and are probably of more recent origin than *rogersi. Fatifera* is closest to *missouriensis,* and replaces that species in the Atlantic Coastal Plain and in Florida. The differentiation between these two species is probably correlated with differences in climate and in the habitats occupied in their respective ranges.

In group 2, *hubbelli* appears to be a dark derivative of the more northern *turricola.* However, the genitalia also bear resemblances to those of *ornatipes* and *escambiensis.*

In group 3, *patellonigra* is a gray species that resembles *pikei* in color, type of habitat occupied, and poorly developed turret-building habits. Like *pikei* it gives evidence of long restriction to coastal habitats or similar situations, but differs from *pikei* in genitalia and ventral markings. The affinities of *wrightii* are still uncertain. It somewhat resembles *turricola* in appearance and genitalia, but the fundamental genitalic structure seems to be closer to that of *pikei.*

Group 4 includes the two species *ornatipes* and *escambiensis,* which are very similar and closely related, and the affinities of which with the other members of the genus are not apparent. They differ from each other in markings, genitalia, and range.

Group 5 includes the single species described herein as *micanopy.* This species occurs over most of Florida, but as yet has not been taken outside the state. I have not been able to determine its relationships to the other members of the genus. The relationships of *rafaelana* and *gosoga* are likewise obscure.

In studying the relationships between the species, other characters besides those of the genitalia and ventral color pattern were considered. Structural proportions, armature of the chelicerae, eye proportions and arrangement, and chaetotaxy were studied for possible evidence of kinship. Either no differences were found, or the differences were considerably smaller than the range of individual variation, and thus could not be relied upon for clear-cut specific differentiation.

Methods

Two types of specimens were used in this study. The bulk of the material was preserved in 95% alcohol and studied while immersed in alcohol; color and pattern were described as seen under alcohol unless otherwise noted. Colors given in the descriptions were determined by comparison with Ridgway, 1912, under the artificial yellow light of an ordinary microscope lamp. Dried study specimens were prepared by running alcoholic specimens through three changes each of 95% alcohol, 100% alcohol, and xylene, period of immersal in each solution one day. Upon removal from the xylene the specimens were pinned and their legs spread into a desired position and allowed to dry. Specimens prepared in such a manner are quite life-like in appearance, since shrinkage is not excessive and coloration is little altered. This series of dried

specimens, although small, proved quite useful and instructive; it made an ideal way to study the differences in appearance between species and brought out nicely the considerable amount of variation in appearance which sometimes exists among members of the same species. This method is particularly recommended to those students who would study the zoogeographic relations of the group.

Drawings of the epigyna, where internal structures are shown, were made from specimens treated with KOH and mounted in balsam. All measurements were made with a measuring microscope. The epigyna and palpi were drawn to scale by the author, so that an idea of their size relationships can be acquired by studying the figures. The outline drawings of the carapace are also to scale. Mr. Brudon's drawings of the ventral surface were made x3, and by careful measurement; hence those drawings also record important differences in size and proportion.

The drawings of the ventral surface were intended to illustrate the ventral color pattern, which is of value in separating the species. Mr. Brudon was restricted to black and white reproduction so no attempt was made to represent the various shades of yellow, red, and brown which are characteristic of living and preserved specimens. The pattern shown in the drawings is that produced by pigmented areas, black, or various shades of grey, in color. The artist was also handicapped in his reproduction of the shades of grey by his restriction to the use of stipple. For example: it sometimes became a question whether to portray a certain pattern, or to darken a certain leg segment, with a dark stipple or solid black. Inconsistencies were bound to result. For this reason, each figure of the ventral surface is briefly discussed in the captions.

Males can be collected only at certain seasons, usually during some one period of a month to six weeks. For this reason it is advisable to note the location of colonies while collecting, and to visit those colonies at intervals during the season when maturity is to be expected. Another useful procedure is to bring penultimate instar males and females into the laboratory and feed them until they undergo the last moult. About the only precaution necessary is that of keeping each individual in a separate container.

The abbreviations used in this paper are as follows:

A.M.N.H.—Specimens belonging to the American Museum of Natural History, New York, N. Y.

Cat.—The author's field catalogue.

Cornell—Specimens belonging to Cornell University, Ithaca, N. Y. (Included in the Cornell collection were a number of specimens belonging to S. C. Bishop of the University of Rochester).

juv.—Juvenile or young specimens.

M.C.Z.—Specimens belonging to the Museum of Comparative Zoology, Harvard College, Cambridge, Mass.

pen.—Penultimate instar stage.

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This revision has been made possible largely through the kindness of those who have loaned specimens or helped in other ways. Miss Elizabeth B. Bryant and Nathan Banks loaned me the M.C.Z. collection of *Geolycosa;* Dr. W. J. Gertsch sent the specimens in his care at the American Museum of Natural History; and Dr. Sherman C. Bishop made the Cornell collection available. Included in the shipment of the latter collection were specimens belonging to the University of Rochester. Individuals who have contributed specimens or loaned their personal collections are W. M. Barrows, I. J. Cantrall, A. M. Chickering, D. C. Lowrie, A. G. Peterson, and B. J. Kaston.

During the past six years numerous individuals connected with the Biology Department at the University of Florida have contributed specimens or have been helpful in other ways. Among those who have aided by collecting material are W. M. Beck, F. N. Young, H. H. Hobbs, Jr., T. H. Hubbell, J. I. Friauf, W. McLane, L. Berner, A. F. Carr, Jr., A. Laessle, F. Norman, and G. Pournelle. Dr. T. H. Hubbell has read and criticised the manuscript. Mr. W. L. Brudon contributed the drawings of the ventral surface, a very generous gesture indeed.

The ownership or disposition of specimens, other than my own, is indicated along with the data pertaining to those specimens. For example: *G. wrightii* (Em.), Ill., Lake Co., Sept. 21, 1935, D. C. Lowrie—1 ♂, 1 ♀, 3 small immatures (Lowrie). The name following the date is that of the collector, the name in parenthesis denotes ownership and disposition of specimens. Where no collector is indicated but the author's catalogue number is given, it frequently is the case that a collecting party made the collection. Most of the individuals concerned have been mentioned above.

I wish to express my appreciation of the cooperation outlined above and to thank everyone who has contributed to the writing of this paper.

GEOLYCOSA Montgomery

1904. *Geolycosa*, new genus, Montgomery. Proc. Acad. Nat. Sci. Phil.:292-293. [*Genotype*—*G. latifrons*, n. sp.].

The principal characteristics of the genus, as at present understood, have been discussed in the introduction.

KEY TO THE MALES

1.	Occurring east of the Mississippi River	2.
1'.	Occurring west of the Mississippi River	18.
2(1).	All segments of all legs dark or black, *banded* with light gray hairs; carapace and abdomen black above and below, covered with light pubescence; palpi like fig. 41. (Matures in early spring) ....*rogersi*, n. sp., p.	17.
2'.	Not so	3.
3(2').	Legs III and IV dark beneath on all segments, not banded, femora lighter than the other segments; palpi like fig. 40. (Matures in fall; known only from Florida) .....*micanopy*, n. sp., p.	40.
3'.	Not so, some segments of leg IV light in color	4.
4(3').	Leg III dark beneath on all segments; femur IV reddish or yellowish in color. (Known only from Florida)	5.
4'	Not so, leg III with several segments light beneath	6.
5(4).	Length of median apophysis one-fourth that of cymbium, palpi like fig. 40. (Matures in October and November, except Florida West Coast form) .....*micanopy*, n. sp.,	40.
5'.	Length of median apophysis one-seventh that of cymbium; palpi like fig. 37. (Matures in March and April) .....*hubbelli*, n. sp., p.	37.
6(4').	Femora I and II black or dusky beneath	7.

6′.	Not so, femora light, unmarked below	9.
7(6).	Median apophysis approximately one-fourth as long as cymbium, like fig. 40.	*micanopy*, n. sp., p. 40.
7′.	Median apophysis less than one-fifth as long as cymbium	8.
8(7′).	Patellae and proximal ends of tibiae III and IV black beneath; palpi like fig. 44. (Florida)	*patellonigra*, n. sp., p. 23.
8′.	Not so, or palpi like fig. 45. (Georgia northward)	*pikei*, p. 20.
9(6′).	Venter black, or with a median black band	10.
9′.	Venter light or dusky, not black	13.
10(9).	Patellae I and II black beneath	21.
10′.	Patellae I and II not black beneath	11.
11(10′).	Entire venter black	22.
11′.	Venter with a median dark or dusky band	12.
12(11′).	Distal end of metatarsus I black beneath for less than one-half the length of the segment, or median apophysis like that of fig. 38.	*ornatipes*, p. 32.
12′.	Distal end of metatarsus I black beneath for one-half the length of the segment, or median apophysis like that of fig. 39.	*escambiensis*, n. sp., p. 34.
13(9′).	Patellae I and II dark beneath	14.
13′.	Patellae I and II light beneath	15.
14(13).	Ventral edge of median apophysis curved, as shown in fig. 33.	*fatifera*, p. 9.
14′.	Ventral edge of median apophysis straight, as shown in fig. 42.	*turricola*, p. 26.
15(13′).	Ventral edge of median apophysis curved proximally	16.
15′.	Ventral edge of median apophysis more or less straight, not curved as above	17.
16(15).	Tibiae III and IV usually dusky beneath, venter usually dusky; palpi like fig. 33. (Occurs in Florida and the Atlantic Coastal plain)	*fatifera*, p. 9.
16′.	Tibiae III and IV usually light, venter light; palpi like fig. 34. (Occurs north of the Appalachians and west of the Mississippi)	*missouriensis*, p. 13.
17(15′).	Palpi like fig. 38; distal end of metatarsus I black beneath for less than one-half the length of the segment	*ornatipes*, p. 32.
17′.	Palpi like fig. 39; distal end of metatarsus I black beneath for more than one-half the length of the segment	*escambiensis*, n. sp., p. 34.
18(1′).	Patella I and II black beneath[2]	*riograndae*, n. sp., p. 49.
18′.	Not so	19.
19(18′).	Venter black	*wrightii*, p. 29.
19′.	Venter light	20.
20(19′).	Tibia and metatarsus II with some black beneath; palpi like fig. 34.	*missouriensis*, p. 13 or *uinticolens*, p. 49.
20′.	Tibia and metatarsus II without black markings; palpi like fig. 36.	*latifrons*, p. 45.
21(10).	Tibiae and metatarsi III and IV dusky to black beneath; palpi like fig. 33.	*fatifera*, p. 9.
21′.	Tibiae and metatarsi III and IV not dusky; palpi like fig. 42.	*turricola*, p. 26.

2 *Rafaelana* and *gosoga* are not included in Key to males.

22′. Tibiae III and IV dusky to black; palpi like fig. 33. (Occurring in Florida and in the Atlantic Coastal Plain). ..... *fatifera*, p. 9.

22(11). Legs III and IV light on all segments; palpi like fig. 43. (Occurring in the vicinity of the Great Lakes, or at least not southern in distribution). ..... *wrightii*, p. 29.

KEY TO THE FEMALES

1. Occurring east of the Mississippi River ..... 2.

1′. Occurring west of the Mississippi River ..... 19.

2(1). Legs and body uniformly quite dark, or black ..... 3.

2′. Not so, some segments of legs light in color, or with a light dorsal stripe on carapace ..... 4.

3(2). Guide of epigynum narrowing to a knife-like ridge anteriorly; figs. 66, 67 ..... *rogersi*, n. sp., p. 17.

3′. Guide of epigynum narrow anteriorly, but not forming knife-like ridge; figs. 48, 49. (South Florida) ..... *fatifera*, p. 9.

4(2′). Femur I light or yellow in color beneath ..... 5.

4′. Femur I dusky to black beneath, not yellow or light ..... 15.

5(4). Patellae I and II dark or black. (Normal in *turricola*. Specimens of three other species, *missouriensis*, *fatifera*, and *wrightii*, which normally have patellae I and II light, occasionally have these segments dark or black) ..... 6.

5′. Patellae I and II light or yellow beneath ..... 9.

6(5). Furrows alongside guide of epigynum relatively deep and narrow anteriorly, as shown in fig. 53. ..... 8.

6′. Furrows alongside guide of epigynum relatively shallow and expanded anteriorly, as shown in fig. 50. ..... 7.

7(6′). Epigynum like figs. 46, 47. (Venter sometimes dusky; segments of legs III and IV, distad of femora, usually dusky; carapace dusky, usually with no cephalic light area; Atlantic Coastal Plain and Florida) ..... *fatifera*, p. 9.

7′. Epigynum like figs. 50, 51. (Venter usually yellow, immaculate, all segments legs III and IV usually yellow beneath, not dusky; cephalothorax often with some indication of a light cephalic area; Central Lowlands, Great Plains, etc.) ..... *missouriensis*, p. 13.

8(6). Venter jet black over entire surface ..... *wrightii*, p. 29.

8′. Venter not jet black over entire surface, usually only with a median dark band ..... *turricola*, p. 26.

9(5′). Venter of abdomen black ..... 10.

9′. Venter of abdomen dusky or light, not black ..... 11.

10(9). Lateral furrows of epigynum narrow anteriorly; figs. 55, 56. (Venter usually jet black; Great Lakes region ..... *wrightii*, p. 29.

10′. Lateral furrows wide anteriorly; figs. 69, 70. (Venter usually not jet black; Southeastern States) ..... *ornatipes*, p. 32.

11(9′). Tibia I black or dark beneath over its entire length ..... 12.

11′. Tibia I light proximad ..... 13.

12(11). Epigynum like figs. 46, 47. (Venter sometimes dusky; segments of legs III and IV, distad of femora, usually dusky; carapace dusky, usually with no cephalic area; Atlantic Coastal Plain and Florida) ..... *fatifera*, p. 9.

12′. Epigynum like figs. 50, 51. (Venter usually yellow, immaculate; all seg-

ments legs III and IV usually yellow beneath, not dusky; cephalothorax often with some indication of a light cephalic area; Central Lowlands, Great Plains, etc.) ..... *missouriensis*, p. 13.

13(11'). Epigynum resembling figs. 50, 51; 1.0 mm. long or longer ..... *missouriensis*, p. 13.

13'. Epigynum not resembling figs. 50, 51; less than 0.8 mm. long ..... 14.

14(13'). Black mark on tibia I usually extending proximad only to, or a little beyond, the middle pair of spines. (Many examples of females of the two species in this couplet are indistinguishable) ..... *escambiensis*, n. sp., p. 34.

14'. Black mark on tibia I usually extending proximad to, or almost to, the proximal pair of spines ..... *ornatipes*, p. 32.

15(4'). Lateral furrows alongside guide of epigynum narrow anteriorly, as in figs. 64, 65. ..... *hubbelli*, n. sp., p. 37.

15'. Lateral furrows wide anteriorly ..... 16.

16(15'). Epigynum usually 1.0 mm. long or longer, resembling figs. 72, 73. ..... *micanopy*, n. sp., p. 40.

16'. Epigynum usually 0.8 mm. long, or less ..... 17.

17(16'). Entire venter dark or black ..... 29.

17'. Venter light, or with a median dark band which is usually widest anteriorly ..... 18.

18(17'). Guide of epigynum usually conspicuously constricted at a point slightly in front of its middle, figs. 60, 61; patellae and proximal ends of tibiae III and IV dark to black. (Florida) ..... *patellonigra*, n. sp., p. 23.

18'. Guide of epigynum not so conspicuously constricted, figs. 62, 63. (Georgia northward) ..... *pikei*, p. 20.

19(1'). Legs and body dusky or black ..... *rafaelana*, p. 48.

19'. Not so, legs with one or more segments light. ..... 20.

20(19'). Venter dark or black ..... 21.

20'. Venter light ..... 25.

21(20). Patellae I and II dark or black beneath ..... 22.

21'. Patella I and II light beneath ..... *wrightii*, p. 29.

22(21). Entire venter black or dark ..... 28.

22'. Not so, venter dusky or light laterally ..... 23.

23(22'). Epigynum 0.8 mm. long ..... 30.

23'. Epigynum 0.9 mm. long or longer ..... 24.

24(23'). Epigynum like fig. 68. ..... *gosoga*, p. 47.

24'. Epigynum like figs. 57, 58. ..... *rafaelana*, p. 48.

25(20'). Patellae I and II dark beneath ..... 26.

25'. Patellae I and II light beneath ..... 27.

26(25). Epigynum resembling fig. 68, 1.0 mm. long ..... *gosoga*, p. 47.

26'. Epigynum resembling fig. 52, 0.8 mm. long ..... *riograndae*, n. sp., p. 49.

27(25'). Epigynum more than 1.5 mm. long, resembling fig. 74. ..... *latifrons*, p. 45.

27'. Epigynum 1.4 mm. long, or less ..... 31.

28(22). Femur I dusky or dark beneath; epigynum with lateral furrows wide anteriorly, as in fig. 57. ..... *rafaelana*, p. 48.

28'. Femur I light beneath; epigynum usually with narrow furrows anteriorly; as in fig. 55. ..... *wrightii*, p. 29.

29(17). Patellae III and IV darker than remaining segments of these legs; leg III very little if any darker than leg IV, yellowish; epigynum resembling figs. 60, 61. ..... *patellonigra*, n. sp., p. 23.

29'. Not so, leg III darker than leg IV, the latter reddish rather than yellowish beneath; epigynum not resembling figs. 60, 61. ..... *hubbelli*, n. sp., p. 37.

30(23). Carapace with a dorsal stripe ..... *riograndae*, n. sp., p. 49.
30'. Carapace without a dorsal stripe ..... *rafaelana*, p. 48.
31(27') Epigynum 1.0 mm. long, or longer, resembling figs. 50, 51, *uinticolens*, p. 49, ... or *missouriensis*, p. 13.
31'. Epigynum less than 1.0 mm. long, like fig. 59. ..... *uinticolens*, p. 49.

Note: Occasional specimens of some of the more variable species may prove difficult to identify by means of these keys. This will also probably be true for some of the western species, which are known from so few specimens that the extent of their variability has not yet been determined.

The use of the descriptive terms "light", "dusky", "dark", and "black" may also give trouble. Frequently, specimens that, to the naked eye, appear to have a black segment, will be found to look dark but not black under the microscope. If it looks black to the naked eye it is described as black. "Light" is used when no black pigment is evident.

GEOLYCOSA FATIFERA (Hentz)

Figs. 3, 4, 33, 46, 47, 48, 49, 75, 85, 96, 106

1842. *Lycosa fatifera* Hentz [in part—the "piceous variety" from Alabama]. Journ. Bost. Soc. Nat. Hist. **4**:229; pl. viii, f. 8. (Reprint) Spiders U. S., p. 26; pl. 2, f. 8. [No types were selected or preserved; nothing of the Hentz collection remains, except pins and labels].

1900. *Lycosa missouriensis* Banks, Banks. Proc. Acad. Nat. Sci. Phil., p. 538. [2♀♀—the only specimens known from Alabama; now in the collection of the Museum of Comparative Zoology at Harvard.]

1908. *Lycosa fatifera* Hentz, Chamberlin [in part]. Proc. Acad. Nat. Sci. Phil., pp. 241-243; pl. 20, f. 8.

1910. *Lycosa fatifera* Hentz, Chamberlin [in part]. Canadian Entomologist **42**(1):17.

1911. *Geolycosa fatifera* (Hentz), Petrunkevitch [in part]. Bull. Amer. Mus. Nat. Hist. **29**:554.

1911. *Geolycosa missouriensis* (Banks), Banks. Proc. Acad. Nat. Sci. Phi. **63**:454.

1912. *Lycosa missouriensis* Banks, Emerton [in part—those from N. C.]. Psyche **19**(2):34.

(?)1913. *Lycosa fatifera*, Comstock [in part]. Spider Book, p. 636.

1925. *Lycosa fatifera*, Chamberlin [in part]. Bull. Mus. Comp. Zool. Harvard **67**(4):230.

Description of a Male (from palmetto-pine flatwoods on road from Gainesville to Newnan's Lake, Alachua Co., Fla., Sept. 19, 1938, Cat. 1047—F. N. Young and H. K. Wallace, collectors.) In alcohol—Median stripe of carapace wide, narrowing to a point behind the dorsal groove, covered with golden pubescence; this pubescence obscures somewhat the English Red color of the carapace in the region of the dorsal stripe; lateral margins of carapace covered with pubescence which is almost white; remainder of carapace quite dark with a reddish or chestnut tinge. Dorsum covered with Pallid Mouse Gray and black pubesecnce forming a distinct pattern and beset with numerous black bristles. Venter and region cephalad of epigastric furrow Pale Orange Yellow, cephalo-median part of venter bearing black pubescence which forms an indistinct triangle with the apex directed posteriorly. Sternum, endites, coxae, trochanters, all femora and patellae beneath, and all segments of the palpi except the cymbium, near Orange Chrome; labium darker; patella I beneath marked with dark color distally. All tibiae dark, almost black, below

and above metatarsi I-III the same; metatarsus IV light proximally; tibiae and metatarsi bearing light pubescence above which in life lightens the color of these segments considerably. Chelicerae considerably darker than femora. Femora somewhat darker above than below.

Carapace longer than wide (8.4 mm./5.8 mm.), 3.4 mm. high; width of the head 4.1 mm. Posterior eye quadrangle wider than long (2.1 mm./1.5 mm.), eyes of median row larger than those of the posterior; median row slightly wider than anterior row (1.6 mm./1.5 mm.). Anterior row of eyes slightly procurved, the eyes evenly spaced, medians approximately 0.3 mm. in diameter, about twice as large as the laterals. Lower margin of the furrow of the chelicera armed with three equal teeth, equally spaced. Distance from the top of the posterior median eyes to the clypeus 1.1 mm. Palpal sements: femur 3.5 mm., patella 1.7 mm., tibia 1.7 mm., cybium 2.7 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	7.2	3.2	5.7	6.1	3.4	25.6
II	6.5	2.9	4.9	5.7	3.1	23.1
III	5.8	2.6	4.0	5.5	3.0	20.9
IV	7.5	3.1	6.3	8.5	3.9	29.3

Description of a Female: (from transitional flatwoods on edge of San Felasco Hammock, Gainesville, Alachua Co., Fla., Mar. 4, 1940, Cat. 1093.) In alcohol—Dorsum and carapace without markings, carapace near Auburn, dorsum and sides of abdomen near Medal Bronze in color. Sides of venter lighter than dorsum, venter with a narrow median area about same color as dorsum. Sternum, coxae, trochanters, and all femora beneath, including palpal femora, near Cadmium Yellow; endites and labium darker. All tibiae, metatarsi, and tarsi dark beneath; those of legs I-III almost black, those of leg IV lighter; patellae marked with black beneath; patellae, tibiae, and tarsi of palpi near English Red. Chelicerae dark, almost black.

Carapace longer than wide (10.8 mm./6.6 mm.), 4.3 mm. high; width of the head 5.6 mm. Posterior eye quadrangle wider than long (2.7 mm./1.9 mm.), median eyes larger than laterals. Posterior median row the same width as the anterior row (1.9 mm.); anterior row slightly procurved, eyes, about equally spaced, medians approximately 0.4 mm. in diameter, approximately twice as large as the laterals. Lower margin of the furrow of the cehlicera armed with three equal teeth, the teeth equally spaced. Distance from the top of the posterior median eyes to the clypeus 1.5 mm. Palpal segments: femur 3.6 mm., patella 1.7 mm., tibia 1.9 mm., tarsus and claws 3.0 mm. Distance from posterior edge of the vulva or epigynum to anterior end of furrow of vulva 1.0 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	6.5	3.6	4.8	4.9	3.0	22.8
II	5.8	3.1	4.0	4.3	2.9	20.1
III	4.9	2.9	3.2	4.4	2.8	18.2
IV	6.4	3.4	5.2	6.8	3.5	25.3

Specimens Recorded: 104—3 ♂♂, 60 ♀♀, 41 juv. (Some of the juv. were kept alive—4 ♂♂ and several females matured in captivity.)

Geographic Distribution: Atlantic Coastal Plain from New Jersey to Florida and westward to Missouri. I have not seen males from New Jersey or Missouri, and in consequence may have wrongly identified the females from those states which seem to agree with the form here described as *fatifera*.

Records: FLORIDA: *Alachua Co.:* Earlton Beach, Apr. 7, 1937, Cat. 588, flatwoods —1 ♀ with egg case; 1.3 miles east of Alachua Co. Courthouse on Fla. State Road No. 14, Feb. 15, 1938, Cat. 1021, high flatwoods—1 juv.; near Hatchet Creek, Feb. 5, 1938, Cat. 1003, flatwoods—2 juv.; 1.5 miles east of Hatchet Creek, Feb. 5, 1938, Cat. 1004, flatwoods—5 ♀♀, 4 juv.; near San Felasco Hammock, Mar. 4, 1940, Cat. 1093, transitional flatwoods—7 ♀♀ and juv.; near San Felasco Hammock, Feb. 11, 1938, Cat. 1013, transitional flatwoods—6 ♀♀, 11 juv.; near San Felasco Hammock, Feb. 24, 1940, Cat. 1092, transitional flatwoods—5 ♀♀, 1 juv.; near San Felasco Hammock, Feb. 3, 1938, Cat. 620—2 ♀♀, 5 juv.; road to Newnan's Lake, Gainesville, Feb. 19, 1938, flatwoods— 3 ♀♀; near Orange Heights, Sept. 13, 1938, Cat. 1046, flatwoods—2 ♀♀, 2 pen. ♂♂; near Orange Heights, Feb. 5, 1938, Cat. 1005, flatwoods—7 juv.; Gainesville, Sept. 19, 1938, Cat. 1047, flatwoods—3 ♂♂, 5 ♀♀, 2 pen. ♂♂, 2 pen. ♀♀. *Clay Co.:* 3.3 miles north of Keystone Heights, Oct. 15, 1938, Cat. 1053, turkey oak—1 ♀. *Duval Co.:* 10 miles east of Baldwin on U. S. 90, June 3, 1940, Cat. 1906, flatwoods—2 juv. *Escambia Co.:* Pensacola, Jan. 1-8, 1935, W. M. Barrows—1♀. *Marion Co.:* 21.7 miles from Gainesville on Fla. State Road No. 47A, Jan. 31, 1939, Cat. 1064—1 juv. *Okechobee Co.:* Ft. Bassinger, Dec. 28, 1937, D. S. Riggs—1 ♀, juv. *Putnam Co.:* 40 miles east of Alachua Co. Courthouse on Fla. State Road No. 14, Jan. 23, 1939, Cat. 1063B, flatwods— 3 ♀♀. *Walton Co.:* 5 miles east of DeFuniak Springs, Nov. 14, 1938, I. J. Cantrall—1 juv.

GEORGIA: *Jenkins Co.:* Millen, Mar. 27, 1939, H. H. Hobbs, Jr., flatwoods—6 ♀♀.

LOUISIANA: Jennings—1♀ (Cornell).

MISSOURI: Kansas City, Aug. 1931, R. Macy—1 ♀ (A. M. N. H.).

NEW JERSEY: *Bergen Co.:* Ramsey, June 5, 1938, W. J. Gertsch—1 ♀ with egg case (A. M. N. H.).

NORTH CAROLINA: *Alamance Co.:* Burlington, April 1934, Kenneth Wallace—1 ♀; *Lee Co.:* Rocky River near Sanford, April 26, 1938—4 ♀♀ and juv. (A. M. N. H.). *Orange Co.:* Chapel Hill, G. F. Atkinson—1 ♀ (M. C. Z.). *Durham Co.:* Durham—2 ♀♀ with young (M C. Z.).

In addition to the specimens recorded above, one male and four penultimate instar females were collected from rocky (limestone) soil at Coconut Grove, Dade Co., Fla., Sept. 2-5, 1938. Two of the females matured during September and one during October; the other was preserved while immature. I have listed these specimens separately because they differ to some extent from *fatifera* of central Florida and may represent a distinct form.

Life History: The only males of this species that are known were collected in September in Alachua Co., Fla. Females with egg cases were collected in April in the same county. One female with egg case taken at Ramsey, N. J., in June suggests that the eggs are laid somewhat later in the northern than in the southern part of the range. Penultimate instar males collected in September in Alachua Co., Fla., matured before the end of the month. The evidence suggests strongly that it takes this species two years to complete the life cycle: copulation occurs in the fall, fertilization and egg-laying in the spring, hatching in summer, and immatures winter over and reach maturity the following fall. If this is true, in the spring one should find about half-grown (1 year

old) juveniles and adult ♀♀ with egg cases or young; in the middle of the summer very tiny, newly-hatched young and penultimate instar young; in the fall small young and adult males and females; during the winter only adult ♀♀ and small young which are somewhat larger than they were in the fall. So far as my observations go they are in agreement with these predictions.

Habitat: This species is, I believe, the most mesic of all the *Geolycosas* in its selection of habitat. In Florida it has a spotty occurrence in pine flatwoods in areas that are not inundated during any part of the year. One of the characteristics of our flatwoods is that large areas in them are flooded during the rainy season. Naturally, such conditions would not be suitable to a burrowing species. Usually, however, there are high spots in the flatwoods which remain out of water during the wet season, and it is here that *fatifera* occurs. Furthermore, this species appears to be scarce in areas where shade is marked or leaf fall heavy, but since practically all of our flatwoods have been extensively lumbered plenty of open spaces are available.

Variation: Adult females of this species differ considerably in size and coloration. These variations are both individual and geographic in nature. The individual differences will be described first.

Frequently, among as few as a half dozen specimens, one finds some adult females three times as large as others, and their patterns, particularly the markings of the legs and venter, differ considerably. The color range is from dusky individuals with patellae, tibiae, and metatarsi of all legs almost black, to lighter individuals in which only the tibiae and metatarsi of legs I and II are dark. The venter is usually dusky, but not black as in *hubbelli*. Sometimes it bears a distinct median dark band; sometimes it is quite light in color and unmarked, as in *missouriensis*. The vulva or epigynum also exhibits some individual variation, and sometimes differs noticeably from the typical form of epigynum figured here (Figs. 46 and 47).

The geographical variation noted is in color, there being a tendency to become darker from north to south until, in south Florida, we find specimens uniformly black in color—as black as *rogesri*. The differences in coloration between specimens from central Florida and Dade County are quite marked (in the specimens available) and may indicate a distinct break in the continuity of distribution of the species. The epigynum of the Dade County form also differs from that of the central Florida form (in the specimens seen), but these differences are such that they may have resulted from the Dade County specimens having been reared in captivity (Fig. 48 and 49). In the more northern part of the range *fatifera* tends to be lighter in color but usually differs from *missouriensis* in having a dusky venter and dusky segments on legs III and IV.

The single male from Dade County resembles central Florida specimens in coloration and conformation of the genitalia. It should be noted, however, that this specimen was freshly moulted when caught and appears abnormal in some respects. It was accidentally killed while being removed from its burrow.

Observations and Remarks: This species usually constructs a turret about three-fourths of an inch high. A good place to look for burrows is around palmetto clumps in burned-over flatwoods. The burrows are sometimes difficult to find, especially in regions where grasses and shrubs abound. For this reason it is advisable to collect in burned-over areas.

Geolycosa fatifera (Hentz) is obviously closely related to *missouriensis* (Banks). Superficially they resemble each other closely, but their genitalia are distinct. It may be that, when males have been taken from a wider area, this species will be found to intergrade with *missouriensis*.

GEOLYCOSA MISSOURIENSIS (Banks)

Figs. 1, 2, 34, 50, 51, 76, 86, 97, 107

1895a. *Lycosa missouriensis* Banks. Ent. News, p. 206. [♀ type from near Springfield, Missouri].

1899. *Lycosa domifex* Hancock. Ent. News **10**(2):23-29; figs. 1-2.

1899a. *Lycosa domifex* Hancock. Ent. News **10**:168-170.

1902. *Lycosa arenicola* Scudder, Montgomery [in part]. Proc. Acad. Nat. Sci. Phil., pp. 550-552.

1904. *Geolycosa arenicola* (Scudder), Montgomery [in part]. Proc. Acad. Nat. Sci. Phil., p. 299.

1904. *Scaptocosa missouriensis* (Banks), Banks. Jour. N. Y. Ent Soc. **12**:113.

1908. *Lycosa arenicola* Scudder, Chamberlin [in part] and *Lycosa fatifera* Hentz, Chamberlin [in part]. Proc. Acad. Nat. Sci. Phil., pp. 239-243.

1909. *L. missouriensis* Banks, Emerton. Trans. Conn. Acad. Arts and Sciences **17**:205.

1910. *L. nidifex* Marx [in part] and *L. fatifera* Hentz [in part], Chamberlin. Canadian Entomologist **42**(1):17-22.

1911. *Geolycosa fatifera* (Hentz), Petrunkevitch [in part]. Bull. Amer. Mus. Nat. Hist. **29**:554.

1912. *Lycosa missouriensis* Banks, Emerton [in part]. Psyche **19**(2):25-36; Pl. 4, f. 3-3c; Fig. 1c, 4.

1913. *Lycosa fatifera*, Comstock [in part]. Spider Book, p. 636.

1928. *Lycosa fatifera* Hentz, Crosby and Bishop. Memoir 101, Cornell Univ. Agr. Exp. Sta., p. 1067.

1932. *Geolycosa missouriensis* Banks, Banks, Newport and Bird. Univ. Okla. Biol. Sur. **4**(2):30; fig. 6.

(?) 1935. *Lycosa fatifera* (Hentz), Bryant. Psyche **42**(2):80.

1936. *Lycosa fatifera* Hentz, Chamberlin. Proc. Biol. Soc. Wash. **49**:15.

1939. *Geolycosa fatifera* (Htz.), Kurata. Canadian Field-Naturalist **53**(6):80-83.

1939a. *Lycosa missouriensis* Banks, Kurata. Canadian Field-Naturalist **53**(6): 84-85; 1 fig.

Description of a Male (Mich., Cheboygan Co., Douglas Lake, Sept. 16, 1939, I. J. Cantrall): In alcohol—Carapace rubbed, sides near Antique Brown; with a rather obscure dorsal stripe which is somewhat lighter than the sides, as wide as the posterior eye quadrangle behind the posterior lateral eyes, narrows in front of the dorsal groove and is indistinct from there posteriorly. Dorsum of abdomen near Ochraceous-Buff with a faint hastate mark and dark chevrons; the first chevrons are located about halfway back along

the hastate mark and the second pair at the posterior end of the hastate mark. Sternum, coxae, endites, venter, and femora III and IV near Warm-Buff; labium quite dark; anterior edge of venter quite dark (Fig. 1); middle five-sixths of tibiae I and II black beneath, the black area enclosing the proximal pair of spines but not the distal pair; metatarsi I and II black beneath; cybium dark, other palpal segments light.

Carapace longer than wide (8.4 mm./5.9 mm.), 2.8 mm. high; width of the head 3.9 mm. Posterior eye quadrangle wider than long (2.1 mm./1.5 mm.), the posterior median eyes somewhat larger than the laterals (0.7 mm./0.6 mm.); the posterior median row slightly wider than the anterior row (1.6/1.5 mm.). Anterior row of eyes almost straight, only very slightly procurved, the eyes about evenly spaced, medians only slightly larger than laterals (0.3 mm./ 0.2 plus mm.). Lower margin of the furrow of the chelicera with three teeth; the median and middle teeth equal and contiguous at their bases, the lateral smaller and somewhat removed. Distance from the top of the posterior median eyes to the clypeus 1.1 mm. Palpal segments: femur 3.6 mm., patella 1.7 mm., tibia 1.9 mm., cymbium 2.8 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	6.8	3.1	5.3	5.4	3.4	24.0
II	6.3	2.9	4.6	4.9	3.1	21.8
III	5.5	2.5	3.8	4.9	3.0	19.7
IV	6.7	2.8	5.6	6.8	3.4	25.3

Description of a Female (Mich., Cheboygan Co., Sept. 15, 1939, I. J. Cantrall): In alcohol—Dorsum of abdomen and sides of carapace near Brussel's Brown; carapace in front of and around dorsal groove a little lighter than on sides, otherwise uniform in color; dorsum of abdomen without discernible markings. Femora, coxae, sternum, and venter near Orange-Buff; labium and endites dark; patellae somewhat darker than femora but not dusky; distal nine-tenths tibia I and seven-eights tibia II black beneath, the black area in each case enclosing the proximal pair of spines; metatarsi I and II black beneath; tarsi I and II quite dark; patellae, tibiae, metatarsi, and tarsi III and IV darker than femora, with a reddish cast, but not dusky; venter unmarked. For color plate see Emerton, 1912.

Carapace longer than wide (9.7 mm./6.8 mm.), 3.8 mm. high; width of head 5.1 mm. Posterior eye quadrangle wider than long (2.5 mm./1.7 mm.), posterior median eyes approximately the same size as the laterals (0.7 mm.); posterior median row slightly wider than the anterior row (1.9 mm./1.8 mm.). Anterior row of eyes only slightly procurved, the eyes about evenly spaced, medians only slightly larger than laterals (approx. 0.4 mm./0.3 mm.). Lower margin of furrow and chelicera with three teeth, median and middle teeth equal and contiguous at their bases, lateral smaller and somewhat removed from the other two. Distance from top posterior median eyes to clypeus 1.3 mm. Palpal segments: femur 3.7 mm., patella 1.7 mm., tibia 2.1 mm., tarsus and claws 2.9 mm. Distance from posterior edge of guide of epigynum to the anterior end of the furrow of epigynum 1.1 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	6.5	3.4	4.9	4.6	3.0	22.4
II	5.8	3.2	4.1	4.4	2.9	20.4
III	5.2	2.8	3.5	4.5	2.9	18.9
IV	6.6	3.3	5.3	6.4	3.5	25.1

Specimens Recorded: 93—10 ♂♂, 56 ♀♀, 27 immatures.

Geographic Distribution: Missouriensis is the most widely distributed member of the genus. Specimens available indicate that it occurs throughout the Central Lowlands and Great Plains Province of Fenneman, 1928. It also apparently extends southward onto the Coastal Plain of Texas, and may occur west of the eastern flank of the Rockies. *Uinticolens,* an almost indistinguishable relative of *missouriensis,* occurs on the Colorado Plateaus; and in a recent communication R. V. Chamberlin has informed me that *missouriensis* is common on the campus of the University of Utah, Salt Lake City. Unfortunately, only a few specimens of the genus have been collected west of the Great Plains. Additional western material will throw much light on the zoogeography of this group.

Records: CANADA: *Manitoba,* Ameme, June 27, 1917—1 ♀ (M. C. Z.).

ARIZONA: *Apache Co.:* 5.8 miles south of Springerville, Aug. 16, 1935, 7600 feet, I. J. Cantrall—1 ♀ and immature.

COLORADO: *Douglas Co.:* Castlerock, June 8, 1912, A. G. Vestal—1 ♀ (M. C. Z.). *Jefferson Co.:* Denver, Mar. 11, 1938, Van Riper—1 ♀.

ILLINOIS: *Cook Co.:* Pine, near Chicago, Oct. 8, 1908, W. H. Wright—1 ♀ (M. C. Z.); Buffington, Chicago, May 21—1 ♀ and immatures (M. C. Z.). *Franklin Co.:* Ziegler, Apr. 20, 1930, J. K. K. Karlovic—2 ♀♀ (Lowrie). *Kankakee Co.:* Pembroke Twp., Jan. 6, 1935—1 small immature (Lowrie); Pembroke Twp., Nov. 23, 1935, D. C. Lowrie—1 ♀ (Lowrie); Pembroke Twp., May 12, 1936, D. C. Lowrie—3 ♀♀, 11 immatures (Lowrie); Pembroke Twp., May 25, 1938, D. C. Lowrie—2 immatures (Lowrie). *Lake Co.:* Waukegan Flats, Apr. 2, 1935, D. C. Lowrie—1 ♂; Waukegan Flats, May 1, 1935, D. C. Lowrie—2 ♀♀ and 2 immatures (Lowrie). *Mason Co.:* Havana, Oct. 7, 1910, A. G. Vestal—1 ♂ (M. C. Z.).

INDIANA: Buffington, May 21, 1910—2 ♀♀ (M. C. Z.); Buffington (Chicago), May 21, 1910—1 ♀ and 1 immature (M. C. Z.); Buffington, Mr. Wright—2 ♀♀ (M. C. Z. 885); 6338 Ellis Ave., Chicago (?)—2 ♀♀, Oct. 8, 1908, W. H. Wright (M. C. Z.) *Pulaski Co.:* Pulaski, Oct. 6, 1930, J. J. Davis—1 ♀ (Cornell).

KANSAS: *Franklin Co.:* 4 miles southeast of Ottawa, Oct. 1935, W. Clanton—1 ♂; *Ottawa Co.:* Delphos, June 30—1 ♀ (M. C. Z.).

IOWA: *Woodbury Co.:* Sioux City, Sept. 28, 1915—1 ♂ (M. C. Z.); Sioux City, C. N. Ainslie—1 ♀ and immature (A. M. N. H.).

MICHIGAN: *Cheboygan Co.:* Douglas Lake, July 1922, R. Matheson—1 ♀ (Cornell); Douglas Lake, The Gorge, June 28, 1932, R. L. H. B. —1 ♀; I. J. Cantrall collected the following at Douglas Lake: No. 6, May 26, 1939—2 immatures; No. 7, May 26, 1939—1 immature; No. 9, May 27, 1939—1 immature; No. 14, May 27, 1939—1 ♀; No. 16, May 29, 1939—1 immature; No. 17, May 29, 1939—1 juv. ♂, 1 juv. ♀; No. 19, May 29, 1939—2 immatures; No. 28, Sept. 15, 1939—1 ♀; No. 35, Sept. 16, 1939—1 ♂; No. 36, Sept. 16, 1939—1 ♀. *Iosco Co.:* East Tawas, June 18-21, 1920, W. M. Barrows—1 ♀ (A. M. N. H.). *Livingston Co.:* George Reserve, Apr. 13, 1938, I. J. Cantrall—1 ♀.

MINNESOTA: *Anoka Co.:* Fridley Sand Dunes, Oct. 1931, J. E. Moore—1 ♀ (A. M. N. H.); *Hennepin Co.:* Minneapolis, Oct. 1931, W. J. Gertsch—1 ♀ (A. M. N. H.).

MISSOURI: *Boone Co.:* Columbia, June 7, 1938, A. G. Peterson—1 ♀.

NEW MEXICO: *San Miguel Co.:* Las Vegas—1 ♀ (M. C. Z.); *Otero Co.:* Camp Mary White, Aug. 1934, S. Mulaik—2 ♀♀ (A. M. N. H.).

NEW YORK: *Monroe Co.:* Sea Breeze, Sept. 13, 1914—1 ♂, 1 ♀ (Cornell).

OHIO: *Lucas Co.:* 5 miles west of Toledo, Sept. 24, 1938, I. J. Cantrall—2 ♀♀. *Erie Co.:* Sandusky, May 19, 1910—2 immatures (M. C. Z.).

OKLAHOMA: Specimens in Cornell collection with following data: C282—1 ♀, C286—1 ♀, C289—2 ♀♀, C1—1 ♀, C290—1 ♀; C292—1 ♀, C296—1 ♀; Galtry, Oct. 13, 1907, P. Haghurst—1 ♂. *Cleveland Co.:* Norman, Oct. 30, 1927—2 ♂♂ (M. C. Z.).*Grady Co.:* Chickasha, Nov. 1928, Shackleford—1 ♀ (Cornell). *Kay Co.:* Ponca City, Nov. 2, 1907—1 ♂ (Cornell). *Kingfisher Co.:* Kingfisher—1 ♀ (Cornell).

SOUTH DAKOTA: *Bon Homme Co.:* Avon, Sept. 1, 1935, A. G. Peterson—2 ♀♀. *McCook Co.:* Bridgewater, July 7, 1938, Moore—1 ♀ with young. *Sanborn Co.:* Letcher, May 11, 1938, A. G. Peterson—1 ♀.

TEXAS: *Brazos Co.:* Bryan, May 13, 1936, L. G. Browman—1 ♀.

WISCONSIN: *Sauk Co.:* Spring Green, July 1, 1928—1 ♀ (Cornell).

Life History: I am unable to add much information to that given by Emerton in 1912. All the males that I have examined were taken in September, October, or November, except one from Illinois which was collected in April. "Fertilized females live over a second winter and lay eggs in May or June"—Emerton, 1912. See also Kurata, 1939a, p. 84-85. Both sexes pass the winter half grown. I have examined one female with young taken in July. It requires at least two years for this species to complete its life cycle; they reach maturity in the fall, mate, the females winter over and lay their eggs in May and June, the young hatch out during the following summer and pass the second winter half grown.

Habitat: "This species is very abundant in the sand dune country along the Great Lakes"—Emerton, 1912. Ecological data from other parts of its range are lacking or scanty, but the indications are that, excluding forest environments, it may tolerate a rather wide variety of habitats.

Variations: Considering the wide range of this species it is remarkably constant in structure and appearance. Minor variations which I have noted include some in the epigynum and the following deviations from the normal coloration: One female from Chicago, Ill., has dusky patellae I and II; one female from Livingston Co., Mich., has dusky metatarsi and tarsi III and IV; a female from Las Vegas, N. Mex., has less black than usual on tibia and metatarsus II; the same is true for a male from Ponca City, Okla.; a female from Avon, S. Dak., has dusky marks on tibia and metatarsus III and metatarsus IV; a female from Letcher, S. Dak., has dusky tibiae and metatarsi III and IV; a female from Bridgewater, S. Dak., has a dusky venter.

Observations and Remarks: The burrowing habits of *missouriensis* were briefly described by Emerton, 1912—"This species usually constructs a turret, low or high, according to the nature of the surroundings." They were also well described by Hancock (1899) in his account of *L. domifex.* See also Kurata, 1939a.

G. missouriensis is closely related to *G. fatifera,* as has already been pointed out. It can usually be distinguished from all the species except *uinticolens* by referring to the ventral color pattern.

Geolycosa rogersi n. sp.

Figs. 29, 30, 41, 66, 67, 81, 95, 99, 109

Holotype: Male, from "Transitional Flatwoods" near San Felasco Hammock, Gainesville, Alachua Co., Fla., Mar. 4, 1940, Cat. 1093; allotype, a female collected while still immature Feb. 24, 1940, which matured about Mar. 6, 1940, and was preserved Mar. 8, Cat. 1092, same locality: both in the author's collection.

Description of Holotype: In life—Strikingly marked, the arrangement of gray, black, and orange hairs and bristles over a blackish background producing a distinct pattern on the body and a banded effect on the legs. Carapace gray with orange tint over cephalic area; abdomen whitish with black hastate mark. Orange-yellowish bristles give chelicerae an orange-yellowish appearance. Venter black; sternum, coxae, labium, and endites dusky. Distal ends of femora, entire patellae, distal halves of tibiae, and distal ends of metatarsi black above and below—proximal portions gray (color pattern due to disposition of gray and black hairs over black background). In alcohol—Although much of the contrast between the black and gray is lost, the pattern is the same as that described above. In pinned specimens the pattern is quite distinct (see Fig. 29).

Carapace longer than wide (5.8 mm./4.0 mm.), 2.7 mm. high; width of head 3.0 mm. Posterior eye quadrangle wider than long (1.8 mm./1.1 mm.), eyes of median row larger than those of posterior. Median row 1.3 mm. wide, slightly wider than anterior row; anterior row slightly procurved, eyes evenly spaced, medians larger than laterals. Clypeus equals diameter of anterior median eye. Lower margin of furrow of chelicera with three equal teeth, spaced 2—1. (Labium of paratype wider than long (0.9 mm./0.75 mm.), half as long as endite.) Palpal segments: femur 2.3 mm., patella 1.0 mm., tibia 1.0 mm., cymbium 2.1 mm. The holotype is not as completely sclerotized as some of the paratypes, and its median apophysis is considerably lighter in color than that of older and better sclerotized males. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	4.5	1.9	3.6	3.7	2.2	15.9
II	4.0	1.8	2.9	3.5	2.1	14.3
III	3.7	1.7	2.6	3.6	2.0	13.6
IV	4.8	2.0	4.2	5.4	2.6	20.0

Description of Allotype: Female not strikingly marked like the male, instead almost uniformly black, lightened somewhat by white hairs and bristles. In alcohol light hairs are less conspicuous and specimen appears darker than in life. Pinned specimens closely resemble the living, and appear to have a light gray bloom covering legs and body. No pattern on legs or body, alive or in alcohol.

Carapace longer than wide (7.7 mm./4.7 mm.), 2.8 mm. high; width of head 4.1 mm. Posterior eye quadrangle wider than long (2.2 mm./1.3 mm.), median eyes larger than laterals. Posterior median row wider than anterior row (1.6 mm./1.4 mm.), anterior row slightly procurved. Eyes of anterior row about evenly spaced, medians larger than laterals. Clypeus approximately equal to diameter anterior median eye. Lower margin furrow of chelicera with three equal teeth, almost evenly spaced. Distance from top posterior median eye to bottom anterior lateral eye 0.9 mm. Labium slightly longer than wide (1.0 mm./0.9 mm.), half as long as endites (2.1 mm.). Palpal segments: femur 2.5 mm., patella 1.1 mm., tibia 1.2 mm., tarsus and claws 1.9 mm.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	4.0	2.1	3.0	2.9	2.0	14.0
II	3.6	2.0	2.6	2.8	1.9	12.9
III	3.5	1.8	2.2	2.9	1.8	12.2
IV	4.5	2.1	3.9	4.8	2.3	17.6

Specimens Recorded: 60—5 ♂♂, 4 ♀♀, and 51 immatures. (Some of the immatures were kept alive— 11 ♂♂ and 16 ♀♀ matured in captivity).

Geographic Distribution: Known only from scattered localities in Florida and Georgia.

Records: FLORIDA: *Alachua Co.:* Hawthorne Road, Feb. 18, 1938, Cat. 1028, edge of road through high hammock—1 ♀; road from Gainesville to Newnan's Lake, June 21, 1938, edge of field—1 immature; San Felasco, transitional flatwoods, the following: Feb. 3, 1938, Cat. 620—3 pen. ♂♂, 4 pen. ♀♀; Feb. 11, 1938, Cat. 1013—3 ♂♂, 5 pen. ♂♂, 12 pen. ♀♀; Feb. 17, 1938—1 ♂, 3 pen. ♀♀; Feb. 18, 1940—2 pen. ♂♂, 1 pen. ♀; Feb. 24, 1940, Cat. 1092—3 pen. ♂♂, 4 pen. ♀♀; Mar. 4, 1940, Cat. 1093—1 ♂ (holotype), 6 pen. ♀♀. *Duval Co.:* 10 miles east of Baldwin on U. S. 90, June 3, 1940, Cat. 1096, edge of flatwoods—1 ♀. *Flagler Co.:* 20 miles north of Bunnell on Fla. State Road No. 28, Oct. 6, 1940, Cat. 1111, flatwoods—1 juv. ♀. *Jackson Co.:* Apr. 9, 1940, Cat. 1127, road shoulders— 1 immature. *Putnam Co.:* 5 miles west of Palatka, Jan. 23, 1939, Cat. 1063B, flatwoods—1 pen. ♀.

GEORGIA: *Mitchell Co.* 8.1 miles north of Camilla, Apr. 13, 1941, Cat. 1136—2 ♀♀.

Life History: During February, 1938, three adult males and one adult female were collected from their burrows. In addition, eight penultimate instar males and seventeen penultimate instar females were collected and brought alive into the laboratory. All of these matured before the end of February, the first males about a week before the first females. Several males were killed and eaten by females, and a few females escaped from the cages. By March 11 no females had spun egg cases, although four or more pairs had had opportunity to mate. Almost all of the above dug burrows and built turrets when materials for such were made available. A few days after maturing the males would leave their burrows and would wander about their cages in a restless manner—hunting females? In one instance a female abandoned her burrow February 20 and had not returned to it by May 10 when she was found dead in her cage. On June 11 I found a dead female with egg case in her burrow; the eggs were undeveloped and this specimen had had no opportunity to mate. Copulation was observed once—the male matured February 9 or 10 and was placed in a cage with a female February 14. On February

21 at 3:50 P. M. they were seen copulating. The female was at the mouth of her burrow with legs I and II extending out over the edge of the turret. The male was on the female's back—head first into the burrow. He kept vibrating his abdomen as though tapping her on the face. He also kept moving his legs I in such a way that he seemed to be pushing her legs IV apart to give free swing to his palpi, which I could not see. The female remained practically motionless. At 3:59 they parted; the female died June 11 without spinning an egg case.

Two penultimate instar ♂ ♂ and one penultimate instar ♀ were collected Feb. 18, 1940. By March 4 all were mature.

Three penultimate instar ♂ ♂ and six or seven penultimate instar ♀ ♀ were collected Feb. 24, 1940. These matured as follows: March 4—1 ♂; March 6—3 ♀ ♀ (one selected as allotype); March 7—1 ♂; March 11—1 ♂; March 12 to 30—1 ♀.

Six penultimate instar ♀ ♀ were collected March 4, 1940. Two of these matured March 11, the others escaped or died.

The above evidence points to the fact that *rogersi* matures and mates during the latter part of February and the first part of March. This is earlier than in any of the other *Geolycosas* for which the mating season is known. In 1940 the season was a week or so later than in 1938. This may have resulted from the unusually severe winter of 1939-40.

Habitat: Most of my specimens were collected in a limited area near San Felasco Hammock, several miles northwest of Gainesville, Alachua Co., Florida. This area resembles flatwoods in most respects but differs in essential particulars and has been described as "Transitional Flatwoods" (Wallace, M. S.). The scarcity of this species makes it difficult to arrive at satisfactory conclusions regarding its habitat.

Observations and Remarks: At no time have I found this species numerous or the burrows easy to find. It is almost impossible to discover them in unburned areas, and for this reason most of the collecting has been done in burned-over areas. The average bag for more than twenty hours of collecting was about 1 or 2 an hour. On several occasions I have had several helpers for four or more hours, and the catch always ran less than fifteen specimens.

This species always constructs a turret (commonly about three-fourths of an inch high) which is usually quite characteristic in appearance. Leaf fragments are incorporated in the turret, and frequently it is attached to, and supported by, the stems of plants. Sometimes the burrow is found in the center of a clump of grass or other plant with radially disposed leaves, and in these cases the turret is attached to nearby blades or stems. The burrow resembles those of the other *Geolycosas*. In captivity most individuals burrow and build a turret typical for their species if materials are made available.

Judging by the conformation of palp and epigynum this species is the most disjunct of all the members of the genus studied thus far. It can be separated from all the other *Geolycosas* by its genitalia and from most by its black color. It is related to the *missouriensis-fatifera* group.

GEOLYCOSA PIKEI (Marx)

Figs. 27, 28, 45, 62, 63, 79, 89, 103, 113

1877. *Lycosa arenicola* Scudder. Psyche **2**:2-9. [Preoccupied by Cambridge, 1875].

1881. *Tarentula pikei* Marx. American Naturalist **15**:398-399; fig. 4-6 ["Marx left no type specimens" — Emerton, 1912, p. 31. Type locality—"seashore near Brooklyn" (?).]

1883. (?) *Tarentula arenicola* Scudder, remarks of H. C. McCook in the Proc. Acad. Nat. Sci. Phil., pp. 131-132.

1885. *Lycosa nidifex* Marx, Emerton [in part]. Trans. Conn. Acad. Arts and Sciences **6**:487-488; pl. 47, figs. 4, 4a, 4b.

1888. *Lycosa arenicola* Scudder, remarks of H. C. McCook in the Proc. Acad. Nat. Sci. Phil., pp. 333-336. [in part—those from Coffin's Beach, Mass.]

1890. *Lycosa arenicola* Scudder, McCook. American Spiders and Their Spinning Work, Vol. II, p. 336.

1890. *Lycosa arenicola* Scudder, Stone. Proc. Acad. Nat. Sci. Phil., p. 425.

(?) 1895. *Lycosa arenicola* Scudder, Banks. Jour. N. Y. Ent. Soc. **3**:91.

1902. *Lycosa arenicola* Scudder, Montgomery [in part]. Proc. Acad. Nat. Sci. Phil., pp. 550-552.

(?) 1903. *Lycosa arenicola* Scudder, Montgomery. Proc. Acad. Nat. Sci. Phil., p. 647.

1904. *Geolycosa arenicola* (Scudder), Montgomery [in part]. Proc. Acad. Nat. Sci. Phil., p. 299.

1908. *Lycosa nidifex* (Marx) Emerton, Bryant [in part]. Occas. Pap. Bost. Soc. Nat. Hist. **7**(9):84.

1908. *Lycosa arenicola* Scudder, Chamberlin [in part]. Proc. Acad. Nat. Sci. Phil., pp. 239-241, pl. 20, fig. 9.

1909. *Lycosa Pikei* Marx, Chamberlin. Canadian Entomologist **41**(10):376.

1909. *L. Pikei* Marx, Emerton. Trans. Conn. Acad. Arts and Sci. **14**:177, 204-205; pl. 7, figs. 3c, 3d.

1910. *L. Pikei* Marx, Chamberlin. Canadian Entomologist **42**(1):17.

1911. *Geolycosa arenicola* (Scudder), Petrunkevitch [in part]. Bull. Amer. Mus. Nat. Hist. **29**:553-554.

1912. *Lycosa pikei* Marx, Emerton. Psyche **19**(2):25-36; pl. 4, f. 1, 1c; Fig. 1a, 2.

1913. *Lycosa pikei*, Comstock [in part]. Spider Book, p. 635, fig. 721i.

1925. *Lycosa arenicola*, Chamberlin. Bull. Mus. Comp. Zool. Harvard **67**(4):230.

1928. *Lycosa pikei* Marx, Crosby and Bishop. Memoir 101, Cornell Univ. Agr. Exp. Sta., p. 1067.

1928. *Lycosa pikei*, Chamberlin. In Chamberlin, R. V. and Gertsch, W. J., Proc. Biol. Soc. Wash. **41**:186.

1936. *Geolycosa arenicola* (Scudder), Kaston. Entomologica Americana **16** (new series), No. 2:103, 127.

1938. *Geolycosa pikei* (Marx), Kaston. Bull. 60, Conn. Geol. and Nat. Hist. Surv., p. 183.

Description of a Male (Jamaica, Long Island, N. Y., N. Pike): In alcohol — Dorsal stripe near Mars Orange, sides of carapace considerably darker; dorsal stripe as wide as posterior eye quadrangle behind the posterior lateral eyes, narrows to the cervical groove and is indistinct from there posteriorly; carapace covered with gray pubescence where it has not been rubbed. Dorsum of abdomen near Snuff Brown with an obscure basal hastate mark and an

obscure dark area enclosing light spots behind. Venter slightly dusky, almost unmarked; patellae and tibiae I and II quite dark beneath, almost black; femora I and II somewhat lighter than tibia I; coxae I and II, sternum, labium, endites, and metatarsi I and II dusky. For color plate showing markings see Emerton, 1912.

Carapace longer than wide (7.4 mm./5.3 mm.), 2.8 mm. high; width of head 3.3 mm. Posterior eye quadrangle wider than long (1.9 mm./1.5 mm.), posterior median eyes larger than the posterior laterals (0.7 mm./0.6 mm.); posterior median row somewhat wider than anterior row (1.5 plus mm./1.4 mm.). Anterior row of eyes procurved, eyes about equally spaced, medians larger than laterals (0.3 mm./0.2 mm.). Lower margin of furrow of chelicera with three equally spaced teeth, lateral tooth smaller than the other two. Distance from top of posterior median eyes to clypeus 1.0 mm. Palpal segments: femur 3.1 mm., 1.5 mm., tibia 1.6 mm., cymbium 2.3 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	6.1	2.8	4.8	4.9	2.8	21.4
II	5.5	2.7	4.2	4.7	2.8	19.9
III	4.9	2.4	3.5	4.5	2.6	17.9
IV	6.1	2.7	5.0	6.2	—	—

Description of a Female (Matawan, N. J., July 3-5, 1929, W. B. Miller): In alcohol—Dorsal stripe near English Red, wider than the posterior eye quadrangle behind the posterior lateral eyes, constricted sharply at the cervical groove and indistinct from there posteriorly; sides of carapace considerably darker than dorsal stripe. Abdomen shrunken, dorsum dusky with obscure dark markings. Venter dusky but not black; patellae and tibiae I and II, and distal three-fourths of metatarsus I black beneath; femora I and II lighter than tibia I; coxae I and II, sternum, labium, and metatarsus II dusky. For color plate showing markings see Emerton, 1912.

Carapace longer than wide (9.5 mm./6.9 mm.), 3.8 mm. high; width of head 5.2 mm. Posterior eye quadrangle wider than long (2.7 mm./2.0mm.), posterior median eyes somewhat larger than posterior laterals (0.8 mm./0.7 plus mm.); posterior median row wider than anterior row (2.0 mm./1.9 mm.). Anterior row of eyes slightly procurved, eyes equally spaced, medians larger than laterals (0.4 mm./0.2 mm.). Lower margin of furrow of chelicera with three equally spaced teeth, lateral tooth smaller than the other two. Distance from top of posterior median eyes to clypeus 1.4 mm. Palpal segments: femur 3.6 mm., patella 1.8 mm., tibia 2.0 mm., tarsus and claws 2.5 mm. Distance from posterior edge of guide of epigynum to anterior end of furrow of epigynum 0.7 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	6.7	3.5	5.0	4.9	2.7	22.8
II	5.9	3.2	4.2	4.6	2.6	20.5
III	5.1	2.8	3.6	4.6	2.8	18.9
IV	6.8	3.3	5.4	6.9	3.4	25.8

Specimens Recorded: 115— 25 ♂♂, 60 ♀♀, 3 juv. ♂♂, 4 juv. ♀♀, 23 immatures.

Geographic Distribution: Atlantic Coastal Plain from Georgia to Maine and also on adjacent islands.

Records: CONNECTICUT: *New Haven Co.:* West Haven, Sept. 8, 1935, B. J. Kaston—1 ♂, 1 ♀; West Haven, Sept. 8, 1936, B. J. Kaston—1 ♂ (A. M. N. H.); North Haven, July 5, 1937, B. J. Kaston—1 ♀ (A. M. N. H.).

GEORGIA: *Burke Co.:* 4 miles east of Waynesboro, June 29, 1939, Cat. 1088b—5 immatures; *Emanuel Co.:* 4 miles east of Swainsboro, Apr. 22, 1938, W. J. Gertsch—6 ♀♀, 1 immature (A. M. N. H. and H. K. W.). *Richmond Co.:* 11.0 miles southwest of Augusta on U. S. 1, May 8, 1937, Cat. 608— 1 ♀, 1 immature.

MASSACHUSETTS: *Barnstable Co.:* Wood's Hole—1 juv. ♀ (M. C. Z.); Wood's Hall [?], July 27, 1901, H. W. Britcher—1 juv. ♂ (M. C. Z.); Truro, Cape Cod, Scudder—2 ♀♀ (M. C. Z.); Provincetown, Aug. 25, 1870—7 ♂♂ (Cornell, lot 87, sub. 48); Provincetown, Sept. 8, 190?—3 ♂♂ (M. C. Z.). *Bristol Co.:* Westport, July 28, 1930, R. Dorr—1 ♀ (M. C. Z.). *Dukes Co.:* Martha's Vineyard, Sept. 20, 1882—1 ♂, 1 ♀ (M. C. Z.). *Essex Co.:* Salsbury Beach, B. P. Mann—3 ♀♀ (M. C. Z.); Newburyport—1 ♂ (M. C. Z.); Ipswich, May 18, 1901—2 ♀♀, 1 immature; Ipswich, Aug. 20, 1904—1 ♂, 1 ♀ (M. C. Z.); Ipswich, July 22, 1909—1 ♀ with young; Ipswich, Aug. 20, 1909— 3 ♂♂, 1 ♀ (M. C. Z.); Ipswich Beach, Sept. 10-17, 1913, W. Faxon—4 immatures (M. C. Z.); Ipswich, June 17, 1925, H. H. Cleaves—1 immature (Cornell). *Nantucket Co.:* Nantucket, Sept. 11, 1892, S. Henshaw —1 ♂ (M. C. Z.).

NEW JERSEY: Lakehurst or Absecon, 1 ♀; Aug. 1910—1 ♂ (A. M. N. H.); Lahaway, Aug. 2—1 ♀ (A. M. N. H.). *Camden Co.:* south of Haddonfield, Aug. 1932, W. J. Gertsch—3 ♂♂ (A. M. N. H.). *Monmouth Co.:* Matawan, July 3-5, 1929, W. B. Miller—1 ♀ (A. M. N. H.). *Ocean Co.:* Lakehurst, May 1, 1912, J. H. Emerton—2 ♀♀, 1 immature (A. M. N. H.); Lakewood, Apr. 16, 1910—2 ♀♀ (A. M. N. H.).

NEW YORK: Tottenville, June 29, 1920—3 ♀♀ (1 with young) (Cornell); Jamaica, L. I., N. Pike—1 ♂ (A. M. N. H.); L. I. near Brooklyn, "Nicholas Pike through S. H. Scudder"—1 ♀ (M. C. Z.); Hither Hills, L. I., Apr. 5, 1931, S. C. B. —1 ♀ (Cornell); Long Island, Nicholas Pike— 2 ♀♀ (A. M. N. H.); Montauk Point, L. I., May 24, 1924—2 ♀♀ (Cornell); Long Island, May 24, 1924, S. C. Bishop—2 ♀♀ (Cornell). *Nassau Co.: (L. I.)* Bayville—2 ♀♀, 1 juv. ♂, 1 juv. ♀ (M. C. Z.); Cold Spring Harbor—1 ♀, 1 immature (M. C. Z.); Cold Spring Harbor, June 18, 1932, W. J. G. F 6003—1 ♀ with young, 1 juv. ♂, 6 juv. ♀♀ (A. M. N. H.); Merrick, Oct. 1939—2 ♀♀ (A. M. N. H.). *Suffolk Co. (L. I.):* Baiting Hollow, May 23, 1924—3 ♀♀ (Cornell); East Hampton, W. J. G. 5020—2 ♀♀, 1 immature (A. M. N. H.); Bridgehampton, Aug. 28, 1920—1 ♂, 5 ♀♀, 1 immature (Cornell).

NORTH CAROLINA: Fort Fisher, Oct. 22, 1926, S. C. B.—1 ♀, 1 immature (Cornell).

SOUTH CAROLINA: *Marion Co.:* Nichols, Oct. 21, 1926—2 ♀♀ (Cornell).

VIRGINIA: *Norfolk Co.:* Norfolk, Aug. 1903—1 juv. ♀ (M. C. Z.). *Princess Anne Co.* (?): Lynhaven Inlet, Oct. 27, 1926—1 ♀ (Cornell).

Life History: All of the twenty-five males recorded here were taken during August or September. Juvenile males and females with young are found during June and July. Emerton, 1912, has the following to say about the life history: "matures in August and September . . . both sexes pass the winter half grown . . . do not mature until late and the fertilized females live over a second winter and lay eggs in May and June . . . young remain a long time with the mother, in one case as late as September."

Habitat: This is the sandy-beach-inhabiting form of the New England seaboard. It does not construct a turret, or at best a low and inconspicuous

one. In Georgia I have found this species in sandy fields, many miles from the coast.

Variations: In *pikei* patellae and tibiae I and II are black with the other joints of legs I and II varying from dusky to black. Legs III and IV are also sometimes dusky on the patellae or other segments. The venter ranges from quite light to dark examples with a median black band.

Geolycosa patellonigra n. sp.

Figs. 25, 26, 44, 60, 61, 78, 88, 102, 115

Holotype: Male, from road shoulders five miles west of Archer, Levy Co., Fla., on Fla. State Road No. 13, Oct. 13, 1938, Cat. 1049, W. A. McLane and H. K. Wallace; allotype, a female with the same data: both in the author's collection.

Description of Holotype: In alcohol—Median stripe of carapace almost as wide as posterior eye quadrangle behind posterior lateral eyes, narrows to a point behind the dorsal groove; carapace covered with pubescence which appears golden under artificial light; dorsal stripe near Orange Chrome beneath pubescence, sides of carapace considerably darker, near Burnt Sienna. Dorsum of abdomen with an obscure dark reddish cast beneath a dense pubescence of the same color as that on the carapace; beset with numerous black bristles; with a rather indistinct V-shaped mark, the apex of which is directed posteriorly. Venter with a median dark band, sides light. Sternum, coxae, endites, and labium dusky, darker in front than behind; femur and patella of palpus dusky, tibia lighter. Femora I-11, patella I-IV, tibiae I-II, proximal ends of metatarsi III-IV, and distal ends of metatarsi I-II black beneath; other segments light. Chelicerae about same color as dorsal stripe. In life—All except old, rubbed specimens have a distinctive grey appearance from above. Below, the black markings stand out strikingly.

Carapace longer than wide (7.7 mm./6.0 mm.), 2.9 mm. high; width of head 4.0 mm. Posterior eye quadrangle wider than long (2.2 mm./1.8 mm.). eyes of median row slightly larger than those of posterior (0.7 mm./0.65 mm.); median row slightly wider than anterior row (1.8 mm./1.7 mm.). Anterior row of eyes slightly procurved, eyes evenly spaced, medians larger than laterals. Lower margin of furrow of chelicera with three teeth, equally spaced, lateral tooth smaller than the other two. Distance from top posterior median eyes to clypeus 1.2 mm. Palpal segments: femur 3.7 mm., patella 1.7 mm., tibia 1.8 mm., cymbium 2.7 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	7.2	3.3	5.8	6.8	3.6	26.7
II	6.7	3.1	5.2	6.5	3.7	25.2
III	6.1	2.8	4.3	6.1	3.6	22.9
IV	7.5	3.1	6.3	8.8	4.2	29.9

Description of Allotype: Color and markings similar to that of Holotype except for more distinct pattern on dorsum of abdomen, a lighter venter, and more black on metatarsi I-II.

Carapace longer than wide (10.4 mm./7.0 mm.), 4.1 mm. high; width of head 5.5 mm. Posterior eye quadrangle wider than long (2.9 mm./2.1 mm.), median eyes larger than laterals (0.95 mm./0.7 mm.). Posterior median row wider than anterior row (2.2 mm./1.95 mm.); anterior row of eyes slightly procurved, eyes equally spaced, medians about twice as large as laterals. Lower margin of furrow of chelicera with three teeth, evenly spaced, lateral tooth smaller than the other two. Clypeus about 1.5 times the diameter of an anterior median eye. Distance from top posterior median eyes to clypeus 1.5 mm. Palpal segments: femur 3.9 mm., patella 1.9 mm., tibia 2.1 mm., tarsus and claws 3.2 mm. Distance from posterior edge of epigynum to anterior end of furrow of epigynum 0.7 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	7.2	3.7	5.3	5.6	3.1	25.0
II	6.6	3.5	4.7	5.4	3.1	23.3
III	5.9	3.2	3.8	5.2	3.1	21.2
IV	7.5	3.7	5.8	7.9	3.8	28.7

Specimens Recorded: 351—7 ♂♂, 160 ♀♀, 49 pen. ♂♂, 21 pen. ♀♀, 114 juv. (a few specimens listed here as juveniles matured in captivity).

Geographic Distribution: Known only from Florida at present, but probably occurs in Georgia.

Records: FLORIDA: *Alachua Co.:* 1.9 miles west of Archer on Fla. State Road No. 13, road shoulders, Oct. 26, 1940, Cat. 1118, F. N. Young and H. K. Wallace—1 ♂, 1 ♀, 5 pen. ♂♂, 1 pen. ♀. *Brevard Co.:* Titusville, Apr. 1, 1939, Cat. 1078, scrubby-sand area—7 ♀♀; 26.1 miles south of Titusville, Apr. 1, 1939, Cat. 1080, scrub—5 ♀♀, and immatures. *Clay Co.:* Keystone Heights, the following on white sand beach: July 7, 1934, Cat. 307—2 pen. ♂♂, 5 pen. ♀♀; Apr. 21, 1935, Cat. 398—12 ♀♀ (2 with young), 28 juv.; Apr. 23, 1935, Cat. 401—3 juv.; Apr. 26, 1936, Cat. 548—8 ♀♀ (1 egg case and several with young), 3 juv.; Mar. 7, 1937, Cat. 583—5 ♀♀ (1 with egg case containing dried-up eggs), 4 juv.; Feb. 5, 1938, Cat. 1006—17 ♀♀, 4 juv.; Aug. 28, 1938—14 juv.; Oct. 15, 1938, Cat. 1052—2 ♀♀; Oct. 1, 1940, Cat. 1102—4 pen. ♂♂, 1 pen. ♀; Kingsley's Lake, Oct. 15, 1938, Cat. 1054, road shoulders and (?) turkey oak—20 ♀♀, 3 juv.; 14.9 miles north of Starke, June 3, 1940, Cat. 1097, road shoulders through turkey oak—1 ♀, 3 juv. *Lake Co:* Lake Eustis, Nov. 9, 1933, Cat. 235, sand beach—5 ♂♂, 4 juv. *Levy Co.:* 7 miles west of Archer on Fla. State Road No. 13, Oct. 13, 1938, Cat. 1049, road shoulders through turkey oak—ceratiola association—2 ♂♂ *(holotype)*, 13 ♀♀ *(allotype)*, 3 juv. ♀♀, 1 juv. ♂; 5 miles west of Archer, Sept. 29, 1940, Cat. 1100—2 pen. ♂♂, 5 pen. ♀♀; 4 miles west of Archer, Sept. 29, 1940, Cat. 1101—3 pen. ♂♂, 1 ♀, and 4 juv.; 3.7 miles west of Archer, Oct. 26, 1940, Cat. 1119—2 pen. ♂♂, pen. ♀♀, etc. (this species was still immature in this locality early in December, 1940.) *Marion Co.:* Ocala National Forest: June 14, 1935, Cat. 408—3 ♀♀; June 14, 1935, Cat. 411—1 ♂; June 25, 1935, Cat. 414—6 ♀♀, 3 juv.; Oct. 20, 1940, Cat. 1058A—4 ♀♀ (2 with young); Oct. 20, 1940, Cat. 1058B—4 ♀♀ (2 with young); Oct. 20, 1938, Cat. 1059—1 ♀ and immatures; Feb. 18, 1939, Cat. 1065—5 juv.; Mar. 18, 1939, Cat. 1066—3 pen. ♂♂, juveniles, but no adults; May 31, 1940, Cat. 1094—1 pen. ♂, 9 ♀♀, 4 juv.; May 31, 1940, Cat. 1095—1 ♂, 8 ♀♀, 16 pen. ♂♂, 8 pen. ♀♀, 4 juv.; Oct. 6, 1940, Cat. 1115—7 ♀♀ (several with young); 15 miles south of Ocala on U. S. 441, Apr. 30, 1937, Cat. 602, wiregrass-turkey oak—1 ♀. *Orange Co.:* 3.9 miles east of Apopka, Apr. 1, 1939, Cat. 1085, turkey oak—1 ♀; 3.3 miles northwest of Apopka on U. S. 441, Apr. 2, 1939, Cat. 1087—1 ♀. *Pasco Co.:* near Port Richey, Apr. 30, 1937, Cat. 603—2 ♀♀, 4 juv. *Putnam Co.:* 24.9 miles east of Gainesville on Fla. State Road No. 14, May 16, 1938, Cat. 1034—5 ♀♀, 14 juv.;

23 miles east of Gainesville on Fla. 14, Aug. 29, 1938, Cat. 1037—2 pen. ♂♂ (1 matured Oct. 31, the other Nov. 8); 26 miles east of Gainesville on Fla. 14, Jan. 23, 1939, Cat. 1063C—1 ♀; 3.1 miles east of county line on Fla. 14, Oct. 6, 1940, Cat. 1107—1 pen. ♂; 9.4 miles east of county line on Fla. 14, Oct. 6, 1940, Cat. 1108, turkey oak—3 pen. ♂♂ (2 of these matured about Oct. 26), 1 ♀, and 1 pen. ♀. *Volusia Co.:* 9 miles south of New Smyrna on U. S. 1, Aug. 29, 1938, Cat. 1038—3 juv.; 18 miles west of Daytona Beach on Fla. 92, Oct. 6, 1940, Cat. 1113, sand scrub —2 ♂♂, 14 ♀♀, 2 juv.

Life History: The life history pictures that we discover for the spiders described here as *patellonigra*, n. sp. differs considerably from the type presented by most of the other species of *Geolycosa*. Among the latter the life cycle is a series of stages and events which occur during certain months over a period of two years—a seasonal behavior to which all the members of the species adhere quite closely. The *patellonigra* life history, on the other hand, appears to be made up of three or more distinct cycles, for example: (1.) Those living at Keystone Heights mature late in the fall, penultimate males being found as early as July; fertilized females apparently winter over and are found with young and egg sacs in April. (2.) Those living in the Ocala National Forest mature and mate in May and June, and penultimate males are found as early as March; females with young are found in October. (3.) At the type locality a peculiar situation exists. Large males and females mature in October, while a smaller, more numerous, population of penultimate males and females is still immature in December. I have not yet followed the latter group through to maturity, but it is probably not the case that they are next fall's adults.

Besides the differences noted in seasonal occurrence, differences in size and color pattern occur, and in some instances can be correlated with particular life histories. All this is evidence that we are dealing not with a single, homogeneous population, but with one that has broken up or is in the process of breaking up into distinct taxonomic entities. This problem is being actively pursued at present and will be reported on more fully at a later date.

Habitat: The genitalia of *pikei* and *patellonigra* bear convincing evidence that these species are closely related; the habitat relationships of the two furnish still more evidence of the fact. *Pikei* is the Atlantic seaboard sandy-beach-inhabiting species, and, while *patellonigra* is not confined to beaches or the coasts in Florida, still it occurs in situations which are beach-like in nature or represent early stages in the development of inland facies from an original beach or sand dune type of situation. *Patellonigra* occurs on both coasts in suitable situations—sandy fields, sand scrub, etc., and inland in sand scrub or turkey oak associations that appear to have developed on what were once old sand dunes or coastal terraces. With only these facts in mind *patellonigra* is seen as a derivative of *pikei;* a species (or complex) that developed in the southern end of the range, possibly as a result of insulation.

Variations: The genitalia are quite distinctive but the color pattern varies considerably, so much so that the figures given here serve only to illustrate the average appearance. This variation is particularly noticeable in the amount of black on the distal segments of legs I and II, patellae III and IV, and venter.

Sometimes a dark specimen is found in which all four legs are almost black. Presence or absence of a dorsal stripe apparently has no taxonomic significance.

Variation in size and in the life history have already been mentioned; their significance in relation to speciation is being investigated.

Observations and Remarks: The nature of the relationship that exists between *pikei* and *patellonigra* is problematical at present. No males are known for either species from Georgia or the Carolinas. The few females known from these states have been assigned to *pikei* rather arbitrarily.

Like *pikei*, *patellonigra* constructs a low, rather inconspicuous turret when it builds one. Frequently, particularly on bare, sandy areas, there is nothing but a ring of silk around the mouth of the burrow. In regions where bare, sandy areas predominate the lack of a turret is the usual condition.

GEOLYCOSA TURRICOLA (Treat)

Figs. 13, 14, 42, 53, 54, 87, 116

(?)1842.*Lycosa fatifera* Hentz [in part—the bluish black form from Massachusetts]. Journ. Bost. Soc. Nat. Hist. **4**:229; pl. 8, f. 8. (Reprint) Spiders U. S., p. 26, pl. 2, f. 8. [No types were selected; apparently none of Hentz's specimens are in existence].

1870. *Lycosa species*, Emerton. American Naturalist **4**:664-665; fig. 138.

1880. *Tarentula turricola* Treat. Harper's Monthly, pp. 710-718 and 857-861. [Type locality, New Jersey, by inference].

1881. *Tarentula nidifex* Marx, American Naturalist **15**:396-398; figs. 1-3.

1883. *Tarentula arenicola* Scudder, remarks of H. C. McCook in Proc. Acad. Nat. Sci. Phil., pp. 131-132.

1885. *Lycosa nidifex* Marx, Emerton (in part). Trans. Conn. Acad. Arts and Sciences **6**:487-488; pl. 47, figs. 4, 4a, 4b.

1888a. *L. arenicola* Scudder, McCook. Proc. Acad. Nat. Sci. Phil., pp. 217-219; fig. 1(2).

1889. *Lycosa arenicola* Scudder, McCook. American Spiders and Their Spinning Work, Vol. I, pp. 19 and 313-314.

1893. *Lycosa arenicola* Scudder, McCook. American Spiders and Their Spinning Work, Vol. III, pp. 24-26.

(?)1895. *Lycosa arenicola* Scudder, Banks. Jour. N. Y. Ent. Soc. **3**:91.

(?)1902. *Lycosa nidifex* Marx, Emerton. Common Spiders, p. 70, figs. 172-175.

1902. *Lycosa arenicola* Scudder, Montgomery [in part]. Proc. Acad. Nat. Sci. Phil., pp. 550-551.

(?)1903. *Lycosa arenicola* Scudder, Montgomery. Proc. Acad. Nat. Sci. Phil., p. 647.

1904. *Geolycosa arenicola* (Scudder), Montgomery [in part]. Proc. Acad. Nat. Sci. Phil., p. 299.

1904. *Scaptocosa arenicola* (Scudder), Banks. Jour. N. Y. Ent. Soc. **12**:113.

1908. *Lycosa nidifex* (Marx), Emerton, Bryant [in part]. Occas. Pap. Bost. Soc. Nat. Hist. **7**(9):84.

1908. *Lycosa arenicola* Scudder, Chamberlin [in part]. Proc. Acad. Nat. Sci. Phil., pp. 239-241.

1909. *Lycosa nidifex* Marx, Emerton. Trans. Conn. Acad. Arts and Sci. **14**:177, 205; pl. 7, figs. 3 to 3e.

1910. *Lycosa nidifex* Marx, Chamberlin [in part]. Canadian Entomologist **42**(1): 17-22.

1911. *Geolycosa arenicola* (Scudder), Petrunkevitch [in part]. Bull. Amer. Mus. Nat. Hist. **29**:553-554.

1912. *Lycosa nidifex* Marx, Emerton. Psyche **19**(2):25-36; pl. 4, figs. 2-2c; text figs. 1b, 3, 5, 6.

1913. *Lycosa nidifex*, Comstock [in part]. Spider Book, p. 635, fig. 721, 722.

1928. *Lycosa nidifex* Marx, Crosby and Bishop. Memoir 101, Cornell Univ. Agr. Exp. Sta., p. 1067.

1938. *Geolycosa nidifex* (Marx), Kaston. Bull. 60, Conn. Geol. and Nat. Hist. Surv., p. 183.

Description of a Male (N. Y., Long Island, Gt. Pond, Riverhead, May 23, 1924 (Cornell)): In alcohol—Most of the pubescence has been rubbed off the carapace. Dorsal stripe as wide as posterior eye quadrangle behind posterior lateral eyes; near English Red in color, narrowing in front of dorsal groove and indistinct from there posteriorly. Sides of carapace dusky, considerably darker than dorsal stripe. Dorsum of abdomen near Buffy-Brown, with an indistinct central dark area. Patellae I and II beneath, and venter black; distal ends of metatarsi I and II, patellae III and IV, and tibia III dusky beneath—other segments, sternum, coxae, etc. light.

Carapace longer than wide (8.5 mm./6.2 mm.), 2.9 mm. high; width of head 3.9 mm. Posterior eye quadrangle wider than long (2.0 mm./1.5 mm.), eyes of median row somewhat larger than those of the lateral (0.7 mm./0.6 mm.); median and anterior rows of eyes of the same width (1.6 mm.). Anterior row of eyes somewhat procurved, eyes equally spaced, medians appearing slightly larger than laterals but measuring the same (0.3 mm.). Lower margin of furrow of chelicera with three equally spaced teeth, lateral tooth smaller than the other two. Distance from top of posterior median eyes to clypeus 1.1 mm. Palpal segments: femur 3.7 mm., patella 1.7 mm., tibia 1.9 mm., cymbium 2.7 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	7.9	3.4	6.3	6.7	3.6	27.9
II	7.2	3.2	5.6	6.5	3.6	26.1
III	6.4	2.8	4.4	6.2	3.3	23.1
IV	7.9	3.2	6.5	8.7	4.0	30.3

Description of a Female (N. Y., Long Island, Gt. Pond, Riverhead, May 23, 1924 (Cornell)): In alcohol—Carapace near Mars-Orange behind posterior lateral eyes; this specimen has no dorsal stripe although many individuals of the species possess one; sides of carapace darker than stripe region. Dorsum of abdomen quite dark, obscurely marked (this specimen closely resembling *fatifera* from above). Patellae and tibiae I and II and metatarsus I quite dark, almost black; distal half metatarsus II, atellae III and IV, and venter dusky, the other segments near Orange in color. Lower margin of furrow of chelicera with three equally spaced teeth, lateral tooth smaller than the other two.

Carapace longer than wide (9.0 mm./6.5 mm.), 3.4 mm. high; width of head 5.1 mm. Posterior eye quadrangle wider than long (2.5 mm./1.7 mm.), eyes of median row somewhat larger than those of lateral (0.8 mm./0.6 plus mm.); posterior median row of eyes slightly wider than anterior row (1.9 mm./1.8 mm.). Anterior row of eyes slightly procurved, eyes about equally

spaced, medians somewhat larger than laterals (approx. 0.4 mm./0.3 mm.). Distance from top posterior median eyes to clypeus 1.3 mm. Distance from posterior edge of guide of epigynum to anterior end of furrow of epigynum 0.8 mm. Palpal segments: femur 3.4 mm., patella 1.7 mm., tibia 1.9 mm., tarsus and claws 2.9 mm.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	6.6	3.4	4.9	4.8	2.7	22.4
II	5.8	3.1	4.2	4.5	2.6	20.2
III	5.1	2.7	3.3	4.4	2.6	18.1
IV	6.5	3.2	5.2	6.6	3.2	24.7

Specimens Recorded: 53—10 ♂♂, 33 ♀♀, 10 immatures.

Geographic Distribution: Connecticut, Florida, Georgia, Maryland, Massachusetts, N w Hampshire, New Jersey, New York, North Carolina, Tennessee, Virginia, and Pennsylvania.

Records: CONNECTICUT: *New Haven Co.:* New Haven, Oct. 4, 1892—2♀♀ (M. C. Z.).

FLORIDA: *Escambia Co.:* Pheiffer's Pond, April 6, 1934, Cat. 279—6♀♀ (sandy, well-drained hillside).

GEORGIA: Richmond Co.: 11.0 miles southwest of Augusta, May 8, 1937, Cat. 608—2♀♀ (sandy, well-drained hillside).

MARYLAND: *Baltimore Co.:* Baltimore, July—1♂ (A.M.N.H..) *Arendel Co.:* May 24, 1916—2♀♀ (A.M.N.H.).

MASSACHUSETTS: *Essex Co.:* Salem, 2♀♀ (M.C.Z.). *Hampden Co.:* Springfield, J. A. Allen— 1♀ (M.C.Z.). *Middlesex Co.:* Tyngsboro, May 25, 1909—2♂♂ & 1♀ (M.C.Z.); East Concord, May 2, 1914—1 immature (M.C.Z.); Waltham, May 13, 1906 (moulted May 28)—1♂ (M.C.Z.); Wellesley, May 12, 1909—1♂ (M.C.Z.).

NEW HAMPSHIRE: *Hillsborough Co.:* Hollis, August, 1888, Fox —2♀♀ (Cornell).

NEW JERSEY: *Bergen Co.:* Ramsey, May 22, 1938, W. J. Gertsch—4♀♀ (A. M. N. H.); Ramsey, July 16, 1937, Cat. 613—1♀ with young; Ramsey, May 14, 1938, W. J. Gertsch—1♂ (A.M.N.H.). *Middlesex Co.:* Milltown, Sept. 10, 1910—1♀ (A.M.N.H.).—Ac. 3695). *Ocean Co.:* Lakehurst, May 1, 1912 (moulted May 18)—1♂ (M.C.Z.);Lakehurst or Absecon—1♀.

NEW YORK: *Albany Co.:* Albany (Karna), May 16, 1910, W. H. Wright—1♂ (M.C.Z.); Center Station near Albany, May 6, 1890—1 juv. ♂ and 2 juv. ♀♀ (M.C.Z.); Albany, Nov. 13, 1926, S. C. Bishop—1♀ and 2 large immatures (Cornell); Albany, June 6, 1926—2♀♀ (Cornell). *Suffolk Co.:* Gt. Pond, Riverhead, May 23, 1924—1♂, 2♀♀ (Cornell); Long Pond, June 29, 1924—1♀ and 2 immatures (Cornell).

NORTH CAROLINA: *Alamance Co.:* Burlington, June 7, 1933, Cat. 217—1♀ and immatures.

TENNESSEE: *Knox Co.:* Knoxville, 10-18—1♀ (Cornell).

VIRGINIA: *Fairfax Co.:* Falls Church—1♂, 1 juv. ♂, and 1 juv. ♀ (M.C.Z.).

Life History: Most of the records of males of this species are from May; one from Baltimore, Maryland, is from July. Females with young are found in July. Emerton, 1912, stated that the life cycle is completed in one year—"they mature early enough to lay their eggs the next summer." If this is true *turricola* is the only species in the genus which is known to mature in less than two years.

Habitat: This is the inland turret-building species of the New England states. However, it occurs in close proximity to the seashore in suitable habitats. Emerton, 1912, has this to say about its habitat: "This species is common in eastern Massachusetts in sandy soil at least partly covered with sod. At Plymouth it lives in the sandy hills within a quarter of a mile of the seashore where *pikei* lives in the sand fields." I have found *turricola* in well-drained sandy soil in northern Florida and in Georgia, and in North Carolina in pebbly clay that had been baked by the sun until it was quite hard.

Variations: The color of this species varies to such an extent that it is sometimes confused with *pikei* when the genitalia are not taken into account. Usually the femora are light and the venter displays a median dusky band, but sometimes dark specimens are found in which femora I and II are quite dark and the venter black. A specimen from Tyngsboro, Massachusetts, is of this type; another from Ramsey, New Jersey, has in addition legs III and IV dusky. Two females from New Haven, Connecticut, and several males from Massachusetts have light venters. A male from Baltimore, Maryland, has metatarsi I and II light.

In Escambia County, Florida, I found six adult females in close proximity —within a radius of some forty yards. Their color patterns are similar but three specimens are considerably smaller than the others—so small, in fact, that at first glance they might be mistaken for another species. The epigyna of all six females are in conformity; however, the furrows alongside the guide are somewhat more expanded, anteriorly, than they are in New England examples of *turricola*.

Observations and Remarks: This species usually constructs a conspicuous turret, the nature of the turret varying with the location of the burrow and the materials available for its fabrication.

G. turricola can be distinguished from *G. wrightii* and *G. pikei*, the two species with which it is most likely to be confused in the East, by the characters of color pattern and genitalia. The epigynum of *pikei* has lateral furrows which are somewhat expanded anteriorly, while in the other two species they are usually constricted. *Turricola* and *wrightii* differ somewhat in the internal details of their epigyna. The palpi of the males of all three species resemble each other quite closely. The median apophysis of *pikei* is smaller and of somewhat different shape than in the other two species, and the shape of the terminal apophysis also seems to be characteristic. I find it impossible to distinguish between the palpi of *wrightii* and *turricola*, but the strikingly black venter of the former species serves as a ready means of separating the two.

GEOLYCOSA WRIGHTII (Emerton)

Figs. 7, 8, 43, 55, 56, 80, 91, 101, 111

1910. *Lycosa nidifex* Marx, Chamberlin [in part]. Canadian Entomologist **42**(1):17-22; f. 3 and 4.

1912. *Lycosa wrightii* Emerton. Psyche **19**(2):25-36; pl. 4, f. 4-4d; Fig. 1d. [Emerton did not designate types, nor did he label any specimens as types. Therefore, all the specimens he had before him and from which he cited localities in his descrip-

tion are cotypes; all, or most, of these specimens are in the M. C. Z. collection. Miss E. B. Bryant informs me that the specimen which Emerton probably intended as type is in the M. C. Z. collection and bears the following label in Emerton's writing: *Lycosa wrightii* F.m. ♀. Psyche vol. XIX. April 1912. Chicago, Ill., April 1904. C. B. Davenport.]

(?)1913. *Lycosa pikei*, Comstock [in part]. Spider Book, p. 635.

1925. *Lycosa nidifex* Chamberlin 1910 [not Marx], Chamberlin. Bull. Mus. Comp. Zool. Harvard **67**(4):230.

1932. *Geolycosa writghtii* Emerton, Banks, Newport and Bird. Univ. Okla. Biol. Sur. **4**(2):30.

Description of a Male (Mineral Springs, Dune Acres, Ind., Sept. 3, 1936, D. C. Lowrie): In alcohol—Carapace rubbed, very little pubescence remaining; sides of the carapace dusky, near Antique Brown, head region lighter than the sides as far posteriorly as the cervical grooves; no indication of a dorsal stripe present. [In unrubbed specimens the carapace bears a dense gray pubescence.] Dorsum of the abdomen near Light Ochraceous-Buff, with an obscure hastate mark. Coxae and sternum similar in color to the dorsum of the abdomen; venter black; epigastric region and labium dusky; distal 7/8 tibia I and distal 1/2 metatarsus I quite dark beneath, almost black; the other joints of the legs similar in color to the coxae.

Carapace longer than wide (7.2 mm./5.1 mm.) 2.8 mm. high; width of the head, viewed from above, 3.4 mm. Posterior eye quadrangle wider than long (2.1 mm./1.7 mm.), posterior median eyes slightly larger than posterior laterals (0.7 mm./0.6 mm.); posterior median row distinctly wider than anterior row (1.7 mm./1.4 mm.). Anterior row of eyes procurved, the eyes approximately equally spaced, medians larger than laterals (0.3 mm./0.2 mm.). Lower margin of furrow of chelicerae with three teeth, the lateral tooth smaller than the other two and more removed from the middle tooth than it is from the median. Distance from top posterior median eyes to clypeus 1.1 mm. Palpal segments: femur 3.0 mm., patella, 1.4 mm., tibia 1.6 mm., cymbium 2.3 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	6.2	2.7	4.7	4.7	2.8	21.1
II	5.7	2.4	4.1	4.6	2.7	19.5
III	5.2	2.3	3.7	5.0	2.8	19.0
IV	6.2	2.6	5.1	6.7	3.2	23.8

Description of a Female (Mineral Springs, Dune Acres, Ind., Sept. 3, 1936, D. C. Lowrie): In alcohol—Sides of the carapace a little lighter than Antique Brown, head region in front of cervical grooves much lighter than sides of carapace; the light colored head region might be interpreted as a wide dorsal stripe which is constricted to a point in front of the dorsal groove—however, in unrubbed specimens the carapace is covered with a uniform gray pubescence. Color and markings of legs and abdomen similar to those of male. For color plate see Emerton, 1912.

Carapace longer than wide (8.6 mm./6.1 mm.), 3.9 mm. high; width of the head from above 4.5 mm. Posterior eye quadrangle wider than long (2.5 mm./1.9 mm.), posterior median eyes larger than laterals (0.8 mm./0.7 mm.);

posterior median row wider than anterior row (2.0 mm./1.8 mm.). Anterior row of eyes slightly procurved, the eyes evenly spaced, medians larger than laterals (0.4 mm./0.3 mm.). Lower margin of furrow of chelicerae with three equally spaced teeth, lateral tooth a little smaller than the other two. Distance from top posterior median eyes to clypeus 1.3 mm. Palpal segments: femur 3.3 mm., patella 1.7 mm., tibia 1.7 mm., tarsus and claw 2.7 mm. Distance from posterior edge of guide of epigynum to anterior end of furrow of epigynum 0.8 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	6.1	3.0	4.2	4.0	2.4	19.7
II	5.6	2.9	3.8	3.9	2.5	18.7
III	5.0	2.7	3.3	4.2	2.5	17.7
IV	6.2	2.9	4.9	6.0	3.0	23.0

Specimens Recorded: 96—26 ♂♂, 46 ♀♀, 4 juv. ♂♂, 9 juv. ♀♀, 13 immatures.

Geographic Distribution: Region around the Great Lakes, probably for the most part on sandy wastes; westward to South Dakota and northward into Manitoba; it has been recorded from Oklahoma by Banks. *G. wrightii* probably has a spotty occurrence over a wide area; additional collections will no doubt extend its known range considerably.

Records: CANADA: *Ontario:* "Lake Erie Shore opposite Buffalo, N. Y.," Emerton's label, May 18, 1910—1 ♀, 1 immature [cotypes] (M.C.Z); Pt. Abino, Sept. 11, 1926, W. P. Alexander—1 ♂, 1 ♀ (Cornell). *Manitoba:* Ameme, June 27, 1917—1 juv. ♂, 1 juv. ♀ (M.C.Z.).

ILLINOIS: *Cooke Co.:* Chicago—1 ♀ (M.C.Z.). *Kankakee Co.:* Pembroke Twp., May 12, 1936 (killed July 3, 1936), D. C. Lowrie—3 ♀ ♀. *Lake Co.:* Waukegan Flats, Sept. 21, 1935, D. C. Lowrie—1 ♂, 1 ♀, 3 immatures (Lowrie); Waukegan Flats, April 26, 1936, D. C. Lowrie—2 ♂ ♂, 1 ♀ with young [Note: these males were probably collected as immatures; the label states that the female was killed July 3, 1936]; Waukegan Flats, August 17, 1936, D. C. Lowrie—1 ♂, 1 immature; Waukegan, July 26, 1936, D. C. Lowrie—1 ♀, 1 juv. ♂. *Mason Co.:* Havana, Oct. 7, 1910, A. S. Vestal—1 ♂ [cotype] (M.C.Z.).

INDIANA: 1 ♀ (M.C.Z.); Miller's (Chicago), May 22, 1910—6 ♀ ♀, 3 immatures, 2 egg cases [these are probably cotypes] (M.C.Z.); Buffington, Oct. 1, 1908, W. H. Wright—3 ♀ ♀ [these are probably cotypes] (M.C.Z.); Buffington, Sept. 6, 1909, W. H. Wright—1 ♂ [Emerton probably intended this specimen to be the male type—the label reads "*Lycosa wrightii* Emerton ♂, Psyche, Vol. XIX, April 1912".] (M.C.Z.). *Lake Co.:* Miller, Oct. 18, 1932, D. C. Lowrie—2 ♂ ♂, 2 ♀ ♀ (Lowrie). *Porter Co.:* Dunes State Park, Sept. 30, 1934, D. C. Lowrie—1 ♂, 1 juv. ♀ (Lowrie); Dune Acres, May 3, 1936, D. C. Lowrie—5 ♀ ♀, 1 immature (Lowrie); Dune Acres, July 14, 1936, D. C. Lowrie—3 ♀ ♀, 2 juv. ♂ ♂, 6 juv. ♀ ♀ (Lowrie); Dune Acres, Mineral Springs, August 4, 1936, D. C. Lowrie—1 juv. ♀ (Lowrie); Dune Acres, Mineral Springs, Sept. 3, 1936, D. C. Lowrie—15 ♂ ♂, 11 ♀ ♀ (Lowrie and (H.K.W.); Ogden Dunes, May 20, 1933, R. E. Gregg—1 ♀ (Lowrie); Ogden Dunes, May 12, 1934, D. C. Lowrie—1 immature (Lowrie); Ogden Dunes, May 15, 1937, D. C. Lowrie—1 immature (Lowrie); Tremont, Oct. 12, 1935, D. C. Lowrie—1 ♂ (Lowrie).

MICHIGAN: Lakeside, May 30, 1936, T. Wilder—1 ♀ and immature (Lowrie). *Allegan Co.:* Saugatuck, July 13, 1935, D. C. Lowrie—1 immature (Lowrie).

MINNESOTA: *Ramsey Co.:* St. Paul, July 3, 1923—1 ♀ (Cornell). *Hennepin Co.:* Minneapolis, Oct. 1931, W. J. Gertsch—2 ♀ ♀ (A.M.N.H.).

SOUTH DAKOTA: *Gregory Co.:* Bonesteel, June 28, 1937, A. G. Peterson—1 ♀ with young.

Life History: This species matures in September and October; "mated" females winter over; eggs are laid in the early summer (May); females with young are found in June and July; the young winter over and reach maturity the following September and October.

Habitat: Emerton, 1912, has this to say about its habitat and habits: "lives in sandy country along the Lakes from eastern end of Lake Erie near Buffalo to Chicago, Ill., and south to the middle of Illinois, along the Illinois River. . . . *L. wrightii* also prefers to dig in open sand and makes no turret, or only a rudiment of one."

Variations: Patella I is frequently dark and the black markings on tibia and metatarsus II vary considerably in extent—sometimes leg II is unmarked beneath. The venter is always black. Usually, but not always, the furrows alongside the guide of the epigynum narrow anteriorly. The palpi are constant and resemble those of *turricola*.

GEOLYCOSA ORNATIPES (Bryant)

Figs. 11, 12, 38, 69, 70, 84, 93, 105, 112

1935. *Lycosa ornatipes* Bryant. Psyche **42**(2):78-80; figs. 9, 10. [Holotypic ♂: Florida, Alachua Co., Gainesville, Oct. 31, 1933, A. F. Carr, Jr.; allotypic ♀: Florida, Alachua Co., Biven's Arm, May 6, 1933, H. K. Wallace;—both in the collection of M. C. Z.].

Description of a Male (collected as penultimate instar Aug. 26, 1938, Alachua Co., Fla.—matured Nov. 6, 1938); In alcohol—Medium stripe carapace, behind posterior lateral eyes, almost as wide as posterior eye quadrangle, constricted in front of, and again behind, dorsal groove—does not extend to posterior margin of carapace; median stripe near Maize Yellow in region of dorsal groove, with a reddish tint in region of posterior lateral eyes, covered with whitish pubescence. Sides of carapace quite dark, covered with black pubescence, with a still darker area on each side extending behind posterior lateral eyes to cervical groove. Dorsum of abdomen marked with a median dark area over posterior four-fifths of its length; sides of dorsum clothed with dense, gray, pubescence; scattered black bristles over all. Venter with median dark area constricted posteriorly; edges of venter light; sides of abdomen dark anteriorly. Palpal femur dusky, tibia and metatarsus light. Distal nine-tenths tibia I, distal one-half metatarsus I, distal eight-tenths tibia II, distal one-fifth metatarsus II dark below and above; remainders of these segments and all other segments near Maize Yellow.

Carapace longer than wide (5.2 mm./3.6 mm.), 2.0 mm. high; width of head 2.4 mm. Posterior eye quadrangle wider than long (1.5 mm./1.1 mm.), eyes of median row slightly larger than those of posterior (0.5 mm./0.4 mm.); median row slightly wider than anterior row (1.1 mm./1.0 mm.). Anterior row of eyes slightly procurved, eyes evenly spaced, medians about twice as large as laterals. Lower margin of furrow of chelicera with three equal teeth, equally spaced. Distance from top posterior median eyes to

clypeus 0.8 mm. Palpal segments: femur 2.0 mm., patella 1.0 mm., tibia 1.0 plus mm., cymbium 1.6 plus mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	4.3	1.9	3.6	3.8	2.4	16.1
II	3.9	1.8	3.0	3.5	2.2	14.4
III	3.6	1.6	2.5	3.4	2.1	13.2
IV	4.7	1.8	3.8	5.2	2.6	18.1

Description of a Female (Fla., Alachua Co., Oct. 14, 1938, Cat. 1050): In alcohol—Shade of dorsal stripe similar to that of the male, considerably redder in eye region; sides of carapace uniformly dark, near Burnt Sienna, covered with black pubescence. Dorsum with a median dark area over almost the entire length. Venter with a faintly dusky median area. Distal seven-eights tibia I, distal two-fifths metatarsus I, distal one-third tibia and metatarsus II dark, other segments light; palpal femur dusky, other segments light.

Carapace longer than wide (5.9 mm./3.8 mm.), 2.1 mm. high; width of head 3.0 mm. Posterior eye quadrangle wider than long (1.6 mm./1.3 mm.), eyes of median row slightly larger than those of posterior (0.5 mm./0.4 mm.); median row slightly wider than anterior row (1.4 mm./1.2 mm.). Anterior row of eyes slightly procurved, eyes evenly spaced, medians larger than laterals. Distance from top posterior median eyes to clypeus 0.8 mm. Palpal segments: femur 2.1 mm., patella 1.1 mm., tibia 1.1 mm., tarsus and claws 1.7 mm. Distance from posterior edge of guide of epigynum to anterior end of the furrow of the epigynum 0.7 mm.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	4.1	2.1	2.9	2.9	1.9	13.9
II	3.7	1.9	2.6	2.8	1.8	12.8
III	3.3	1.7	2.1	2.9	1.8	11.8
IV	4.4	2.0	3.4	4.5	2.2	16.5

Specimens Recorded: 177—20 ♂♂, 145 ♀♀, 7 juv. (Two of the males listed here were raised in captivity, another is the Holotype, and seven are lost due to poor preservation).

Geographic Distribution: Florida, east of the Apalachicola River, and Georgia.

Records: FLORIDA: *Alachua Co.:* from old field 1.5 miles north of Fort Clark Church, the following: Oct. 14, 1938, Cat. 1050—7♂♂, 5♀♀, 3 juv.; Jan. 22, 1938, Cat. 615—9♀♀; August 26, 1938—2 juv. ♂♂, large juv. ♀♀ (1 ♂ matured Nov. 6, 1938; the other found mature Jan. 4); Jan. 22, 1938, Cat. 614A—3♀♀; Jon. 22, 1938, Cat. 614B— 3♀♀, 1 juv.; Feb. 12, 1938, Cat. 1014—20♀♀; from transitional flatwoods near San Felasco Hammock, the following: Feb. 3, 1938, Cat. 620—1♀; Feb. 11, 1938, Cat. 1013—4♀♀; Feb. 24, 1940, Cat. 1092—3♀♀; March 4, 1940, Cat. 1093—2♀♀; Hawthorne Road, Feb. 18, 1938, Cat. 1028, road shoulders through live oak hammock—4♀♀; Gainesville, Feb. 15, 1938, Cat. 1022, old field with some turkey oak—3♀♀; Gainesville, 4 miles out Glenn Springs Road, Jan. 31, 1938, Cat. 618B, road shoulders—1♀; Gainesville, Jan. 31, 1938, Cat. 617, old field—4♀♀, 1 juv.; Gainesville, Feb. 19, 1938, sand scrub—1♀; Gainesville, May 22, 1940, turkey oak cut-over and road shoulders—2♀♀ with young; Gainesville, Rattlesnake Branch, May 20, 1937, old field—1♀; Gainesville, March 10, 1937—1♀; Gainesville, Feb. 19, 1938, Cat. 1029, old field—1♀; Gainesville, Feb. 15, 1938, road shoulder—1♀; Gainesville, road to Devil's Mill-

hopper, Feb. 16, 1938—1♀; Gainesville, Jan. 23, 1938, Cat. 616B, road shoulder —1♀; Newberry Road at Airport Hangar, Oct. 25, 1940, H. K. Wallace and J. C. Dickinson—1♂, 4♀♀; old field, Oct. 25, 1940, Cat. 1116—3♂♂, 5♀♀; Gainesville, old field, Oct. 25, 1940, Cat. 1117—3♀♀; 10.0 miles west of Gainesville, Dec. 8, 1940, Cat. 1122—7♀♀. *Levy Co.:* 1.3 miles west of county line on Fla. Highway 13—6♂♂, 28♀♀, 1 juv. ♂, 1 juv. ♀. *Marion Co.:* 18.8 miles from P. K. Yonge School, Gainesville, on U. S. 441, Jan. 31, 1939, Cat. 1064—9♀♀; road shoulders of Fla. State Highway 47A, 28.6 miles from Gainesville, Jan. 31, 1939, Cat. 1064B—1♀; *Madison Co.:* 6 miles west of Suwannee River, Feb. 4, 1938, F. N. Young, high pine—1♀; *Putnam Co.:* 24.9 miles east of Gainesville, May 16, 1938, Cat. 1034, turkey oak—2♀♀; 19.0 miles east of Gainesville, May 16, 1938, Cat. 1033A, edge of high hammock—2♀♀; Palatka, Jan. 23, 1939, Cat. 1063—2♀♀.

GEORGIA: *Richmond Co.:* 11.0 miles southwest of Augusta, May 8, 1937, Cat. 608, old field—1♀; *Pierce Co.:* near Waycross, east of Satilla River, May 8, 1937, Cat. 610, sand scrub—1♀.

Life History: G. ornatipes matures in the fall (October and November), mates, and the females winter over and spin their egg sacs in the spring. My only record of a female carrying young in the field, is from May, 1940, following an unusually cold winter. One female collected on Feb. 11, 1938, burrowed in captivity and was found with an egg case on Mar. 13, 1938; on April 28, 1938, I found this female dead in the bottom of her burrow, the egg case open, and young wandering around in the cage. The evidence cited above strongly indicates that the females carry living sperm over the winter.

I have little evidence on how long it takes this species to complete its life cycle. In the closely related *escambiensis* I found small immatures along with adult males and females, indicating that two years, at least, are required for that species.

Habitat: This species is apparently confined to well-drained sandy soils, but where leaf mould is well developed it is not likely to occur. I have taken it in turkey oak, old fields, and various types of disturbed areas. One of its favorite haunts is road shoulders; another is old fields. *G. ornatipes* and *G. micanopy* frequently occur together.

Variations: see *escambiensis*, new species, page 36.

Observations and Remarks: This species may or may not construct a turret; burrows found in bare sandy stretches are usually devoid of any semblance of a turret, those found in fields or wherever materials for a turret are at hand may have one. When present the turret is usually low and unpretentious.

Geolycosa escambiensis n. sp.

Figs. 9, 10, 39, 71, 83, 94, 104, 114

Holotype: Male, from the east end of Santa Rosa Island, Escambia Co., Fla., Nov. 5, 1938, Cat. 1062; allotype, a female with the same data; both in the author's collection.

Description of Holotype: Median stripe of carapace, behind posterior lateral eyes, almost as wide as posterior eye quadrangle, narrowing to about half that width in front of dorsal groove and extending posteriorly almost to margin of carapace; median stripe near Capucine Yellow, covered with whitish

pubescence; sides of carapace darker than median stripe, with a characteristic pattern as follows: black areas behind posterior lateral eyes delimited posteriorly by cervical groove (in this respect similar to *ornatipes*), another black area on each side delimited anteriorly by the radial furrow which occurs between legs II and III (*in ornatipes* males the sides of the carapace are more or less uniform in color behind the cervical groove); face, clypeus, eye region, margin of carapace, and areas on sides of carapace between black areas covered with whitish pubescence. Dorsum of abdomen covered with whitish pubescence on sides; a central dark band with undulating edges extending over caudal three-fourths of dorsum. Venter with median dusky band; sides with black mark anteriorly. Sternum, coxae, and most segments of legs near Buff Yellow, sternum slightly dusky; palpal femur dusky on sides, other palpal segments light; distal four-fifths of tibia I, distal one-half of metatarsus I, distal one-third of tibia II, and distal one-third of metatarsus II black above and below, remainder of these segments and all other segments near Buff Yellow. Chelicerae about same color as dorsal stripe.

Carapace longer than wide (5.4 mm./3.7 mm.), 2.0 mm. high; width of head 2.8 mm. Posterior eye quadrangle wider than long (1.6 mm./1.2 mm.), eyes of median row slightly larger than those of posterior (0.6 mm./0.5 mm.); median row slightly wider than anterior row (1.2 mm./1.1 mm.). Anterior row of eyes slightly procurved, eyes evenly spaced, medians larger than laterals. Lower margin of furrow of the chelicera with three equal teeth, equally spaced. Distance from top of posterior median eyes to clypeus 0.8 mm. Palpal segments: femur 2.1 mm., patella 1.0 mm., tibia 1.1 mm., cymbium 1.9 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	4.8	2.0	3.8	3.9	2.0	16.5
II	4.2	1.9	3.3	3.7	2.2	15.3
III	3.9	1.7	2.8	3.8	2.2	14.4
IV	5.0	2.0	4.2	5.4	2.7	19.3

Description of Allotype: In alcohol—Median stripe of carapace, behind posterior lateral eyes, about as wide as posterior eye quadrangle; narrowing in front of dorsal groove to about half that width and extending almost to posterior margin of carapace, becoming indistinct posteriorly; median stripe near Capucine Yellow, sides of carapace considerably darker, uniform in color; carapace covered with whitish pubescence not as dense as in male; beset with scattered black bristles. Dorsum of abdomen near a Deep Olive-Drab, covered with whitish pubescence and scattered black bristles; uniform in appearance except for indistinct dark hastate mark. Median area of venter dusky, darker than sides (but light in many *paratypes*); sternum slightly dusky. Distal one-half of tibia and metatarsus I black above and below; remainders of these segments and all other segments near Apricot Yellow except metatarsus II, which has a faint indication of a dark band on the distal end (in some paratypes from the same locality the distal end of metatarsus II is dark). Chelicerae slightly darker than dorsal stripe.

Carapace longer than wide (5.2 mm./3.5 mm.), 2.1 mm. high; width of head 2.8 mm. Posterior eye quadrangle wider than long (1.8 mm./1.3 mm.),

median eyes larger than laterals (0.6 mm./0.5 mm.). Median row wider than anterior row (1.4 mm./1.2 mm.); anterior row of eyes procurved, eyes equally spaced, medians larger than laterals. Lower margin of furrow of chelicera with three equal teeth, equally spaced. Distance from top of posterior median eyes to clypeus 0.9 mm. Palpal segments: femur 2.0 mm., patella 1.0 mm., tibia 1.1 mm., tarsus and claws 1.7 mm. Distance from posterior edge of epipynum to anterior end of furrow of epigynum 0.7 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	3.9	2.0	2.9	2.9	1.8	13.5
II	3.5	1.8	2.5	2.8	1.7	12.3
III	3.1	1.6	2.1	2.8	1.8	11.4
IV	4.1	1.9	3.4	4.3	2.3	16.0

Specimens Recorded: 59—30 ♂♂, 29 ♀♀.

Geographic Distribution: With one exception all of my specimens are from Florida, west of the Apalachicola River. The exception is a single female from Beaufort, N. C. (M. C. Z.), which, in leg markings, resembles *escambiensis* rather than *ornatipes*. Beaufort is on the Atlantic Coast.

Records: FLORIDA: *Calhoun Co.:* 2.3 miles west of Blountstown, Nov. 5, 1938, Cat. 1061, turkey oak—4♀♀; 10 miles west of Blountstown, Nov. 5, 1938, Cat. 1061A, turkey oak—1♀; *Escambia Co.:* Pensacola, June 30, 1925, W. M. Barrows—1♀; east end of Santa Rosa Island, off Destin, Nov. 5, 1938, Cat. 1062, sand scrub—30♂♂, 18♀♀. *Okaloosa Co.:* Niceville, Nov. 6, 1938, old field—1♀; near Niceville, Nov. 6, 1938, road shoulders—3♀♀; *Walton Co.:* 5 miles east of De Funiak Springs, Nov. 14, 1938, I. J. Cantrall—1♀.

(?) NORTH CAROLINA: Beaufort—1♀ (M.C.Z.) [det. dub.]

Life History: Not much is known about the life history of *G. escambiensis*, n. sp., beyond that they mature and mate late in the fall (November).

Habitat: The east end of SantaRosa Island is covered with scrub. This plant association here includes *Quercus geminata*, *Xolisma* species, and *Ceratiola ericoides*. Between the scattered clumps of vegetation are extensive open stretches of bare white sand. Burrows of *G. escambiensis* are found in these open areas; they are often not provided with turrets. On the mainland this species is found in situations similar to those where *ornatipes* occurs in central Florida—namely, road shoulders, well-drained fields, and turkey oak.

Variation: G. escambiensis and *G. ornatipes* are quite closely related and frequently difficult to separate. The latter condition results from the fact that the color pattern of both species is somewhat variable; the palpi of the males are distinct, and they can be separated on this basis, but the genitalia of the females are identical in appearance. There is also some variation in size in both species but the bodily proportions seem to be the same.

In general, *escambiensis* females are lighter colored than those of *ornatipes*. The venter of the former is usually an immaculate yellow, while in the latter a median dusky to dark area is evident. The black mark on tibia I usually extends to, or includes, the proximal pair of spines in *ornatipes* females, while in *escambiensis* it usually extends to, or only barely includes, the middle pair; however, in the latter species this mark sometimes extends to a point midway

between the proximal and middle spines. In *ornatipes* females there is considerable variation in the extent of the black markings on the tibia and metatarsus of leg II; they are usually more extensive than in *escambiensis*.

The males can be separated by referring to figures of the palpi; they also have distinctive patterns on the carapace. Here, again, there exists a certain amount of variation in the extent of the markings on the legs.

Observations and Remarks: Our collecting party arrived on Santa Rosa Island late in the afternoon of Nov. 5, 1938. Just before dark numerous *escambiensis* males were discovered out of their burrows wandering about over the white sand in search of females. The island, at this particular spot, was densely populated with the species. At dusk the headlight was resorted to with success, as a means of collecting, but with darkness the "swarming" activity of *escambiensis* males ceased. No other spiders were observed wandering around until after dark.

The males of *escambiensis* exhibit a marked variation in size but the color pattern is fairly constant. The drawings of the ventral surface of body and legs were not made from the types and the color patterns shown do not agree in all details with the descriptions of the types.

Geolycosa hubbelli n. sp.

Figs. 17, 18, 37, 64, 65, 77, 90, 98, 108

Holotype: Male, from road shoulders of Florida State Road No. 19, at Juniper Springs in the Ocala National Forest, Marion Co., Mar. 18, 1939, Cat. 1066; allotype, a female with egg case from road shoulders of the same highway three miles west of Juniper Springs, Mar. 18, 1939: both in the author's collection.

Description of Holotype: In alcohol—Median stripe of carapace wide, near Mars Orange; dorsum of abdomen somewhat darker, obscurely marked; sides of carapace much darker than median stripe; carapace and dorsum clothed with golden pubescence, no pattern apparent; dorsum bears scattered black bristles; venter and sides of abdomen black; sternum, labium, endites, and coxae dusky; chelicerae similar in color to median stripe of carapace; first three pairs of legs dark beneath, patellae and tibiae I and II almost black, the other segments dusky; leg IV light except for patella and distal ends of tibia and metatarsus, which are dark.

Carapace longer than wide (8.4 mm./5.5 mm.), width of head 3.8 mm. Posterior eye quadrangle wider than long (1.9 mm./1.3 mm.); eyes of median row larger than those of posterior row; median row 1.5 mm. wide, slightly wider than anterior row (1.4 mm.). Anterior row slightly procurved, eyes evenly spaced, medians larger than laterals. Clypeus about equal to diameter anterior median eye. Lower margin of furrow of chelicera with three subequal teeth, equally spaced. Distance from top of posterior median eyes to clypeus 1.1 mm. Palpal segments: femur 3.6 mm., patella 1.5 (?) mm., tibia 2.0 mm., cymbium 2.2 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	7.2	3.1	6.1	6.6	3.6	26.6
II	6.8	2.9	5.5	6.5	3.4	25.1
III	6.0	2.7	4.5	6.2	3.3	22.7
IV	7.6	3.0	6.5	8.9	3.9	29.9

Description of Allotype: In alcohol—An old, rubbed female with egg case; only traces of pubescence remain on carapace. Color more reddish than in *holotype*, markings of legs and body not as brilliant but generally similar to those of *holotype*. Median stripe of carapace wide, near English Red, sides considerably darkened by black pigment. Dorsum of abdomen obscure, with reddish tint; venter black, sides of abdomen dark, somewhat lighter than venter. Sternum, labium, endites and coxae I-III dusky. Chelicerae slightly darker than median stripe of carapace. Legs I-III and palpi dark beneath, leg III not as dark as I and II.

Carapace longer than wide (8.1 mm./5.2 mm.), 3.1 mm. high; width of head 4.4 mm. Posterior eye quadrangle wider than long (2.1 mm./1.5 mm.), median eyes larger than laterals. Posterior median row wider than anterior row (1.7 mm./1.6 mm.); anterior row slightly procurved, eyes about equally spaced, medians larger than laterals. Clypeus 1.5 times diameter of an anterior median eye; distance from top of posterior median eyes to clypeus 1.0 mm. Lower margin of furrow of chelicera with three subequal teeth, evenly spaced —these teeth considerably worn, blunt. Labium 1.1 mm. wide. Palpal segments: femur 3.0 mm., patella 1.4 mm., tibia 1.6 mm., tarsus and claws 2.4 mm. Distance from posterior edge of epigynum to anterior end of furrow of epigynum 0.6 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	5.5	2.9	4.1	4.2	2.3	19.0
II	4.9	2.6	3.5	3.9	2.2	17.1
III	4.4	2.4	2.9	3.8	2.4	15.9
IV	5.7	2.7	4.7	6.0	2.9	22.0

Specimens Recorded: 64—3 ♂♂, 13 ♀♀, and 48 immatures. (Some of the immatures listed here were kept alive, and of these 8 ♂♂ and 3 ♀♀ matured in captivity; a few were killed and eaten by ants while undergoing the last moult).

Geographic Distribution: Known only from Marion Co., Fla.

Records: FLORIDA: *Marion Co.*, Ocala National Forest: Feb. 26, 1938, Cat. 623, F. N. Young, road shoulders—1 pen. ♂, 1 juv.; 15.5 miles east of Silver Springs on Fla. State Road 500, Oct. 20, 1938, Cat. 1058A, road shoulders—1 ♀, 4 juv.; 19.5 miles east of Silver Springs on Fla. 500, Oct. 20, 1938, Cat. 1058B, road shoulders —1 ♀, 2 juv.; Fla. 500, 1 mile east of west boundary markers, Feb. 18, 1939, Cat. 1065, road shoulders—3 pen. ♂♂, 9 pen. ♀♀; Fla. 19 at Juniper Springs, March 18, 1939, Cat. 1066, road shoulders—3♂♂, 3♀♀, 29 pen. ♂♂ and ♀♀; 3 miles west of Juniper Springs on Fla. 19, March 18, 1939, Cat. 1066A, road shoulders—1 ♀ with egg case; 14.5 miles east of Silver Springs on Fla. 500, May 31, 1940, Cat. 1094, road shoulders—1 ♀, 2 immatures; Juniper Springs, May 31, 1940, Cat. 1095, road shoulders—1 ♀, 4 immatures; Oct. 6, 1940, Cat. 1115—3♀♀ (one with young).

Life History: Mature males were collected Mar. 18, 1939. At the same

time penultimate instar males and females were taken and brought alive into the laboratory. Some of these matured during March and April, others were preserved as immatures—a few were killed and eaten by ants in their cages while undergoing the last moult. Two penultimate instar males were collected alive Feb. 18, 1939. One of these matured Mar. 21, the other about Apr. 10. On May 31, 1940, B. A. Barrington and myself collected all day long in the Ocala National Forest. We found unoccupied burrows containing cast skins of males, but no males or penultimate instar males, indicating that the species had already matured and mated. We found adult females without egg cases, and young somewhat less than half grown. The allotypic female, which had an egg case with her in the burrow, was collected Mar. 18, 1939. On Oct. 6, 1940, three females were collected, one of which had young covering her dorsum. These facts indicate that *hubbelli* matures and mates in the spring, during March and April, that the eggs hatch during the summer or fall, and that the young winter over and reach maturity during the third spring. Adult females may be found throughout the year, and one should also at any time be able to find immatures whose size will depend upon the season when taken.

Habitat: Very little is known concerning the habitat relationships of this species, and the fact that all the known specimens are from the Ocala National Forest may be misleading. The forest is a good example of the "sand scrub" vegetational complex (Harper 1915, p. 142, and Hubbell and Goff, 1939, p. 132). Where the scrub is typically developed the vegetation is extremely dense, but open areas occur here and there and a few lakes dot the area. *Geolycosa hubbelli* does not occur in the dense scrub, to the best of my knowledge, and only one or two specimens have been found in open areas and these were close to the highway. This scarcity of individuals everywhere but on the road shoulders leads me to believe that this species is perhaps not native to the "scrub" and that it has migrated along the road shoulders from outside the area since the road has been constructed. However, no "parent" population has been located, either within or outside the Forest.

The road shoulders where *hubbelli* occurs afford an open, sandy, well-drained type of situation. The soil is usually a disturbed member of the St. Lucie, Lakewood, or Dade series—one of the sterile sands with a white, gray, or brown A-horizon and a yellow-orange B-horizon. It supports a relatively scanty growth of grasses and wild flowers which are kept trimmed down by highway workmen. There is considerable glare from exposed areas of sand, and practically no shade. This is probably among the most xeric surface situations in the state. However, the burrows always penetrate to a depth where the sand remains moist, usually some eight to twelve inches.

Observations and Remarks: G. hubbellii always constructs a turret, usually about one inch high, and usually out of grass fragments. With practice it is possible, in most instances, to distinguish their turrets from those of the other species occurring in this region.

Old, rubbed females of *G. hubbelli* and *G. micanopy* sometimes resemble each other very closely. They can be distinguished by examining their genitalia; they do not appear to be closely related. In so far as the genitalia are

concerned *hubbelli* appears to be most closely related to *ornatipes* and *escambiensis*, but differs from these two considerably in other respects.

Sometimes the furrows alongside the guide of the epigynum do not narrow anteriorly as they do in figures 64 and 65.

Geolycosa micanopy n. sp.

Figs. 19-24, 40, 72, 73

Holotype: Male, found wandering at 10:00 A.M., Nov. 2, 1935, Gainesville, Alachua, Co., Fla., Cat. 475; allotype, a female from turkey oak 2.6 miles east of Alachua County Courthouse on Fla. State Highway 14, Gainesville, Fla., Feb. 15, 1938: both in the author's collection.

Description of Holotype: In alcohol—Dorsal stripe near English Red, sides of carapace considerably darker, the whole carapace covered with golden and grayish pubescence where it has not been rubbed; dorsal stripe widest behind posterior lateral eyes, where it is as wide as the posterior eye quadrangle. somewhat narrower in region of dorsal groove, widening again behind dorsal groove and extending almost to posterior margin of carapace. Dorsum of abdomen with gray pubescence and scattered black bristles; with a brownish cast beneath the pubescence; dorsum with dark hastate mark in front and triangular dark area, enclosing paired light spots, behind hastate mark. Venter and sides of abdomen black; femora, patellae, and tibiae I and II black beneath; epigastric region, sternum, labium, coxae I-III, palpal femur, metatarsi I and II, and patella III dusky.

Carapace longer than wide (7.6 mm./5.2 mm.); width of head 3.5 mm. Posterior eye quadrangle wider than long (1.9 mm./1.5 mm.), posterior median eyes larger than laterals (0.7 mm./0.5 mm.); posterior median row slightly wider than anterior row (1.6 mm./1.5 mm.). Anterior row of eyes procurved, eyes evenly spaced, medians somewhat larger than laterals (0.3 mm./0.2 mm.). Lower margin of furrow of chelicera with three evenly spaced teeth, lateral tooth smaller than the other two. Distance from top posterior median eyes to clypeus 1.0 mm. Palpal segments: femur 3.1 mm., patella 1.5 mm., tibia 1.6 mm., cymbium 2.6 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	6.7	2.9	5.5	6.1	3.2	24.4
II	6.1	2.8	4.8	5.7	3.0	22.4
III	5.5	2.4	4.0	5.6	2.9	20.4
IV	6.9	2.8	5.9	7.9	3.7	27.2

Description of Allotype: In alcohol—Color and markings of legs and carapace similar to those of holotype; dorsum of abdomen near Salmon-Orange with hastate mark in front and obscure dark area behind. Venter quite dark, but not black like that of holotype. Carapace longer than wide (9.6 mm./6.3 mm.), 3.9 mm. high; width of head 5.1 mm. Posterior eye quadrangle wider than long (2.5 mm./1.9 mm.), posterior median eyes larger than posterior laterals (0.8 mm./0.7 mm.); posterior median row slightly wider than anterior row (1.9 mm./1.8 plus mm.). Anterior row of eyes slightly procurved, eyes almost evenly spaced, medians slightly larger than laterals

(0.4 mm./0.3 mm.). Lower margin of furrow of chelicera with three teeth, lateral tooth smaller than the other two, and farther from the middle tooth than the middle tooth is from the median. Distance from top of posterior median eyes to clypeus 1.4 mm. Palpal segments: femur 3.5 mm., patella 1.7 mm., tibia 2.0 mm., tarsus and claws 2.9 mm. Distance from the posterior edge of the guide of epigynum to anterior end of furrow of epigynum 1.0 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	6.5	3.4	4.8	4.9	2.7	22.3
II	5.9	3.2	4.2	4.8	2.6	20.7
III	5.3	2.8	3.4	4.9	2.7	19.1
IV	6.9	3.1	5.5	7.4	3.4	26.3

Specimens Recorded: 343—23 ♂♂, 38 juv. ♂♂, 161 ♀♀, 28 juv. ♀♀, 93 immatures. (Of the juveniles listed 13 males and 3 females matured in captivity).

Geographic Distribution: Known only from Florida; occurring from Walton County in the west to Dade County in the south on well-drained, sandy soils. The Everglades probably effect the biggest gap in its distribution.

Records: FLORIDA: *Alachua Co.:* Gainesville, Nov. 2, 1935, Cat. 475—1♂ (Holotype); Gainesville, Jan. 22, 1938, Cat. 614a—1♀, 5 immatures; Gainesville, Jan. 22, 1938, Cat. 614b—1 juv. ♀; Gainesville, Jan. 22, 1938, Cat. 615—1♀, 1 juv. ♀; Gainesville, Jan. 31, 1938, Cat. 618b—1♀; 2.7 miles east of Alachua, Feb. 4, 1938, Cat. 1002—2♀♀; San Felasco, Feb. 11, 1938, Cat. 1013—1 immature; Gainesville, Feb. 12, 1938, Cat. 1014—1♀, 2 juv. ♀♀; Gainesville, Feb. 15, 1938, Cat. 1017—4♀♀, 2 immatures; Gainesville, Feb. 15, 1938, Cat. 1022—1♀; Gainesville, Feb. 15, 1938, Cat. 1022a—1♀; Gainesville, Feb. 18, 1938, Cat. 1028—1♀, 6 immatures; Gainesville, Sept. 14, 1938, Cat. 1045—3 juv. ♂♂, 1 juv. ♀; Gainesville, Oct. 14, 1938, Cat. 1050—2♂♂, 2♀♀, 3 immatures; Gainesville, Oct. 14, 1938, Cat. 1051—3 ♀♀; Gainesville, Feb. 25, 1940—1♀, 1 immature; Gainesville, May 21, 1940—3♀♀; 10 miles west of Gainesville on Fla. 13, Sept. 29, 1940, Cat. 1099—4♂♂, 1 juv. ♂, 6♀♀, 3 juv. ♀♀, 2 half grown immatures; Gainesville, Oct. 1, 1940, Cat. 1103—1♂, 2♀♀, 1 juv. ♂, 1 juv. ♀; Gainesville, Oct. 4, 1940, Cat. 1104—1♀, 2 juv. ♂♂, 5 immatures, 1 juv. ♀; 5.6 miles northwest of Alachua on U. S. 441, Oct. 5, 1940, Cat. 1105—6♂♂, 3 juv. ♂♂, 2♀♀, 2 juv. ♀♀, 3 immatures. *Brevard Co.:* 12.5 miles south of Titusville, April 1, 1939, Cat. 1079—6♀♀; Titusville, April 1, 1939, Cat. 1078—1♀, 1 immature. *Broward Co.:* Ft. Lauderdale, May 27, 1940, B. A. Barrington—1 juv. ♂, 1♀. *Clay Co.:* Keystone *Heights*, March 7, 1937, Cat. 583—1 juv. ♀; 3.3 miles north of Keystone Heights, Oct. 15, 1938, Cat. 1053—2♂♂, 9♀♀; Kingsley Lake, Oct. 15, 1938, Cat. 1054—1♀; 18 miles east of Starke, Oct. 15, 1938, Cat. 1055—3♀♀, 2 immatures. *Collier Co.:* Everglades, Feb., 1935, W. M. Barrows—1♀; 1 mile north of Naples, June 30, 1935, Cat. 434—penultimate males and females (none collected); Naples, Sept. 6, 1938, Cat. 1044—5♀♀ (3 with egg cases). *Columbia Co.:* 0.8 miles NW of Sante Fe River on Fla. 5A, Oct. 5, 1940, Cat. 1106—1♂, 4♀♀, 4 juv. ♂♂, 1 immature. *Dade Co.:* North Miami, August 1938, F. N. Young—2 juv. ♂♂, 2♀♀; Coconut Grove, Sept. 2, 1938, Cat. 1040—1 juv. ♂, 1 juv. ♀; Miami, Sept. 5, 1940, Cat. 1041—3 juv. ♂♂, 2 juv. ♀♀; Miami, Sept. 5, 1938, Cat. 1042—3 juv. ♂♂, 1 juv. ♀; Miami, Sept. 9, 1938, Cat. 1042a—1 juv. ♀. *DeSoto Co.:* Arcadia, March 30, 1938, W. J. Gertsch—6♀♀, 1 immature (A.M.N.H.). *Highlands Co.:* near Palmdale, June 29, 1935, Cat. 431—1♀, 1 juv. ♂, 2 juv. ♀♀. *Hillsborough Co.:* Tampa, Jan. 13, 1938, B. J. Kaston—1 immature. *Lee Co.:* Ft. Myers, Jan. 20, 1930, W. M. Barrows—1♀; Ft. Myers, Feb. 1930, W. M. Barrows—1♀; Ft. Myers, Feb. 1933, W. M. Barrows—1♀, 1 immature; 32 miles east of

Ft. Myers on Fla. 25, June 30, 1935, Cat. 433—2♀♀, 5 juv. ♀♀, 1 juv. ♂; Bonita Springs, Jan. 14, 1938, B. J. Kaston—1 ♀, 2 immatures. *Levy Co.:* 2 miles west of Sumner, April 9, 1937, Cat. 590—2♀♀, 1 juv. ♀; 4 miles west of Archer, Sept. 29, 1940, Cat. 1101—1 juv. ♂, 1♀. *Madison Co.:* 6 miles west of Suwannee River, Feb. 5, 1938, F. N. Young—1 juv. ♀; *Marion Co.:* 15 miles south of Ocala on U. S. 441, April 30, 1937, Cat. 602—2 immatures; 11 miles east of Silver Springs, Oct. 20, 1938, Cat. 1058—1♀, 1 immature; Ocala National Forest, June 14, 1935, Cat. 411—1♀, 1 juv. ♀; Ocala National Forest, Oct. 20, 1938, Cat. 1058a—4♀♀, 1 immature; Ocala National Forest, Feb. 18, 1939, Cat. 1065—3♀♀ (1 with egg case); Juniper Springs, March 18, 1939, Cat. 1066—1♀; Ocala National Forest, March 18, 1939, Cat. 1066a—1♀, 7 immatures; Ocala National Forest, May 31, 1940, Cat. 1094—6 immatures; Ocala National Forest, May 31, 1940, Cat. 1095—6♀♀, 12 immatures; Ocala National Forest, Oct. 6, 1940, Cat. 1115—3♀♀. *Martin Co.:* Jensen, July 5, 1935, Cat. 442—1♀ with young, 1 immature. *Orange Co.:* 9.7 miles NW Apopka, April 2, 1939—1♀; 1.9 miles SE Apopka, April 2, 1939, Cat. 1086—4♀♀, 1 immature; 3.3 miles NW Apopka, April 2, 1939, Cat. 1087—7♀♀ (1 with young); *Palm Beach Co.:* 1.2 miles north of Boca Raton, July 4, 1935, Cat. 440—1♀. *Polk Co.:* 2.2 miles south of Lakeland, June 28, 1935, Cat. 424—2♀♀; 8.3 miles south of Bartow, June 28, 1935, Cat. 426— 1 juv. ♂. *Putnam Co.:* 19.0 miles east of Gainesville, May 16, 1938, Cat. 1033—3♀♀, 6 immatures; 19.0 miles east of Gainesville, May 16, 1938, Cat. 1033a—2♀♀; 15 miles south of Green Cove Springs on U. S. Highway 17, Oct. 15, 1938, Cat. 1056—2♀♀; 2 miles north of Welaka, Jan. 23, 1939, Cat. 1063a—2♀♀, 1 immature; 21.6 miles east of the county line on Fla. State Highway 14, Oct. 6, 1940, Cat. 1109 3♂♂, 5♀♀, 3 immatures; 22.9 miles north of Bunnell on Fla. 28, Oct. 6, 1940, Cat. 1110—2♀♀, 1 juv. ♀, 1 small immature. *St. Johns Co.:* Anastasia Island, March 19, 1938, A. Laessle—1 immature. *Sarasota Co.:* Chadwick Beach, Englewood, W. M. Barrows—1♀, 1 juv. ♂, and immatures; Englewood, March 1, 1938, W. J. Gertsch—1♂, 5♀♀, 3 immatures; Englewood, April 4, 1938, W. J. Gertsch—3 juv. ♂♂. *Volusia Co.:* 9.0 miles south of New Smyrna on U. S. Highway 1, August 29, 1938, Cat. 1038—4 juv. ♂♂, 2 juv. ♀♀; 3.3 miles south of New Smyrna on U.S. 1, April 1, 1939, Cat. 1076—5♀♀, immatures; 5.8 miles south of New Smyrna on U.S. Highway 1, April 1, 1939, Cat. 1077—2♀♀ (1 with young), 1 immature; Ormond, Oct. 6, 1940, Cat. 1112—2 ♂♂, 7♀♀, 2 juv. ♂♂, 1 juv. ♀, 2 half grown imm.; 18 miles west of Daytona Beach on Fla. State Road 92, Oct. 6, 1940, Cat. 1113—4♀♀, 1 imm.; 1.0 mile south of DeSoto Springs on Fla. State Road 17, Oct. 6, 1940, Cat. 1114—2♀♀. *Walton Co.:* 5.0 miles northwest of DeFuniak Springs, Nov. 14, 1938, I. J. Cantrall—1♀.

The population represented by the specimens recorded above constitutes a group rather continuously distributed over the whole of Florida, with the exception of the Everglades and regions where extensive areas of flatwoods occur. Common to this population are (1) fundamentally similar genitalia, (2) fundamentally similar body proportions, (3) similar turret-constructing and burrowing habits, (4) similar patterns on carapace and abdomen, (5) legs I and II dark or dusky beneath. Within the population are differences, various combinations of which fall into somewhat definite geographical regions. The differences or variations noted are: (1) in size of the genitalia, (2) in general color effect of the whole organism, (3) in amount and distribution of black on the legs below, (4) in season of maturity, breeding, and egg-laying. Based upon these differences three sub-groups may be recognized,[3] as follows:

3 Dried, xylol-treated specimens are especially valuable in studying the color differences in these groupings. For method of preparation see page 3. The above discussion refers only to adult specimens.

The Peninsular Group

1. Distribution—central and north Florida.

2. Genitalia somewhat larger than in the other two groups; in the latter practically identical.

3. General color effect reddish, especially noticeable in pinned specimens. Legs III and IV with a reddish cast, leg III usually dusky to quite dark. Femora I and II black beneath. (See Figs. 19 and 20 for ventral pattern.)

4. Season of maturity and breeding late fall; egg-laying in the spring. (This is also true for the East Coast Group).

The East Coast Group

1. Distribution—From Volusia County southward on the east coast of Florida to below Miami; an occasional specimen from the west coast resembles this type.

2. Genitalia smaller than in the Peninsular group, similar to the West Coast group.

3. General color effect grey or olive-buff in living and pinned specimens. A great deal of variation in color markings occurs within this sub-group in the southern part of its range. Specimens from Dade County vary from a type with legs III and IV light and femora I and II only dusky beneath, to melanistic forms in which all four legs are black. (Figs. 21 and 22 illustrate the markings of light colored specimens.)

4. Season of maturity and breeding late fall, as in the Peninsular group.

The West Coast Group

1. Distribution—west coast and inland south of Manatee County; an occasional specimen resembling this type is found on the east coast.

2. Genitalia smaller than in the Peninsular group, resembling the East Coast group more in this respect.

3. General color effect a dark amber. Legs III and IV yellowish rather than reddish or greyish, leg III never black, femora I and II light below on the postaxial surface. (See Figs. 23 and 24 for ventral pattern).

Season of maturity and breeding spring and early summer; egg-laying and young probably June to September.

I am at present of the opinion that the Peninsular and East Coast groups probably represent geographic races of the same species, and that they are physiologically isolated from the West Coast group which is, therefore, a distinct species. This belief is strengthened by the fact that occasional specimens resembling the latter group are found on the east coast, and I have one female with young from Martin County in July—the proper season for the West Coast form. However, my data are scanty; the tentative conclusions

expressed above are intended to direct notice to a problem that needs further investigation.

Habitat: The burrows of this species are usually found in well-drained, sandy soils; road shoulders are one of its favorite haunts. In central and northern Florida it occurs in high pine, turkey oak, old fields, and marginal or transitional situations. It appears to exist in colonies, for the collector can spend fruitless hours in what appears to be suitable situations. I have found numerous burrows in high pine under a very dense undergrowth of wire grass and partridge pea, but the continuous leaf mould and shade of our Florida "hammocks" appear to be prohibitive factors.

On the lower east coast of Florida *micanopy* is found on the white glaring coastal sands, but apparently not on the outer beaches. Around Miami it has also been found burrowing in the rocky limestone soils where they are not subject to inundation. On the lower west coast I have found it on sandy road shoulders and the lawn of the Bass Biological Laboratory at Englewood.

Variations: Besides the variations noted in the preceding discussion, striking differences in size frequently occur. Both males and females may be three or more times the size of what appears to be other members of the same brood. Such local variation in size among the wolf spiders, at least in Florida, is a common phenomenon. Nevertheless, it might easily be confusing to students attempting to identify specimens from keys or figures, and for this reason should be kept in mind during such study.

This species also exhibits some variation in its turret-building habits. As a rule it builds a low turret, but the absence of a turret is not unknown, nor is the presence of an especially high one. It is not always evident that the differences in size of the turret depend upon the materials at hand, for sometimes burrows exhibiting these differences occur within inches of each other.

Western Species

The species of *Geolycosa* known only from west of the Mississippi River are *latifrons, gosoga, rafaelana, uinticolens,* and one new species, *riograndae.* Of these, only *latifrons* can be distinguished, easily, from the other members of the genus. The other four show resemblances among themselves, or are evidently closely related (or possibly identical) with eastern species.

Lycosa gosoga was described from a female collected at Los Angeles, California. Judging from the description, the ventral body and leg pattern resembles that of both *riograndae,* n. sp. and *turricola* Treat. The male is unknown, and until males have been studied the relationships of *gosoga* with the other species must remain conjectural. However, the spatial relationships of *turricola* and *gosoga* are such that it is not probable that they are members of the same species. *Riograndae* females are considerably smaller than the females I have referred to *gosoga* and the markings of the carapace are different.

Lycosa rafaelana was described from immature specimens taken on the San Rafael Desert in Utah. The most outstanding characteristic of this

species is the black color of legs and body. However, I have examined one female from Bluff, Idaho, collected by W. Ivie, which is quite light in color but which appears to conform in structure with black examples of the species. In this female the venter is quite dusky and leg I is faintly dusky; otherwise this specimen is light yellow, differing from *missouriensis* in the pattern on legs I and II and in the dark venter. The epigynum of *rafaelana* closely resembles that of *missouriensis* and can not be relied upon as the sole means of distinguishing between these two species. Males of *rafaelana* are not known with certainty. I have referred four individuals from New Mexico to this species but this may turn out to be an error. The relationships of *rafaelana* are not readily apparent and await the collection of more material.

Lycosa uinticolens was described from a female collected high in the Uintah Mountains of Utah. In his description Chamberlin says "Similar to *Lycosa fatifera* Hentz [here equals *missouriensis* Banks] and *L. gosoga* Chamberlin in having the entire ventral surface of the body light colored and quite without dark markings and in having only the last three joints of the first two pairs of legs black, this color embracing the dorsal as well as the ventral surface." This description and the figure of the epigynum both fit *missouriensis;* the last *four* joints of *gosoga* are black. It is quite possible that *uintocolens* is the same as *missouriensis* but for the present I regard it as distinct because of the locality and elevation where it was collected, and because of a small collection made by Gertsch and Hook 17 miles northeast of Whiteriver in the White Mountains of Arizona. Their 1 ♂, 18 ♀♀, and 3 immatures resemble *missouriensis*—the male appears to be identical, but the females give evidence of some degree of distinctness. In these females the color pattern is constant and identical with that of *missouriensis,* but, while in about half of them the epigynum resembles that of *missouriensis,* in the other half it is considerably different. In this latter group the anterior half of the guide of the epigynum is quite narrow, the furrows alongside the guide are sharply constricted anteriorly, and the whole epigynum is foreshortened in the anterior half (Fig. 59). This collection offers some evidence that a distinct population, close to *missouriensis,* occurs west of the eastern flank of the Rocky Mountains.

G. riograndae n. sp. is represented by 2 ♂♂ and 4 ♀♀ from southern Texas. Their small size and the conformation of their genitalia lead me to believe that they are distinct from both *gosoga* and *turricula,* forms which they resemble.

The conclusions outlined above are based upon a very small number of specimens and it is to be expected that additional specimens will change the picture considerably. Large collections will be necessary before accurate estimates of relationships between the various species will be possible.

GEOLYCOSA LATIFRONS Montgomery

1904. *Geolycosa latifrons* Montgomery, Proc. Acad. Nat. Sci. Phil.: 295-297; Pl. XIX, figs. 15-16. [♂ and ♀ types from the vicinity of Austin, Texas: both in the collection of the American Museum of Natural History.]

1908. *Lycosa fatifera* Hentz, Chamberlin [in part]. Proc. Acad. Nat. Sci. Phil., pp. 241-243.

1910. *Lycosa fatifera* Hentz. Chamberlin [in part]. Canadian Entomologist **42**(1):17.

1911. *Geolycosa fatifera* (Hentz.), Petrunkevitch [in part]. Bull. Amer. Mus. Nat. Hist. **29**:554.

1912. *Lycosa missouriensis* Banks, Emerton. [in part—*latifrons*, Montg.] Psyche **19**(2):34.

Description of Male Type: (Austin, Texas—T. H. Montgomery): In alcohol—Carapace near Cadmium Orange in front of dorsal groove, a little darker on sides and behind the groove; very little pubescence remains on the carapace; legs above, same color as carapace. Dorsum near Buckthorn Brown, with a faintly indicated hastate mark. Sternum, coxae, endites and some segments of legs Mikado Orange, labium and chelicerae darker; venter Pale Orange-Yellow, without markings. Distal seven-eights of tibia I and distal three-fourths of metatarsus I nearly black.

Carapace longer than wide (8.7 mm./5.7 mm.), 3.0 mm. high; width of head 3.9 mm. Posterior eye quadrangle wider than long (2.1 mm./1.6 mm.), posterior median eyes slightly larger than posterior laterals (0.7 mm./0.6 plus mm.); posterior median row wider than the anterior row (1.7 mm./1.5 mm.). Anterior row of eyes slightly procurved, almost equally spaced, median eyes slightly larger than the laterals (0.3 mm./0.2 mm.). Lower margin of furrow of chelicera with three equally spaced teeth, lateral tooth smaller than the other two. Distance from top posterior median eyes to clypeus 1.2 mm. Palpal segments: femur 3.6 mm., patella 1.7 mm., tibia 1.8 mm., cymbium 2.8 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	6.9	3.3	5.6	5.7	3.3	24.8
II	6.1	3.0	4.7	5.2	3.2	22.2
III	5.5	2.6	3.8	5.0	3.0	19.9
IV	6.7	2.9	5.6	7.2	3.7	26.1

Description of Female Type (Austin, Texas—T. H. Montgomery): In alcohol—Carapace rubbed, very little pubescence remaining; carapace near Flame Scarlet in color, no dorsal stripe present; dorsum of the abdomen near Buffy Brown, without definite markings; legs above similar in color to carapace. Sternum, coxae, endites, venter, and ventral aspect of most leg segments near Capucine Yellow; distal seven-eighths of tibia I, and distal three-fourths of metatarsus I nearly black; distal one-half of tibia II dusky.

Carapace longer than wide (10.1 mm./6.8 mm.), 4.1 mm. high; width of head 5.3 mm. Posterior eye quadrangle wider than long (2.7 mm./1.9 mm.), posterior median eyes slightly larger than laterals (0.8 mm./0.7 mm.); posterior median row distinctly wider than anterior row (2.0 mm./1.7 mm.). Anterior row of eyes somewhat procurved, the eyes equally spaced, medians somewhat larger than laterals (approx. 0.4 mm./0.3 mm.). Lower margin of furrow of chelicera with three teeth, lateral tooth smaller than the other two and separated from middle tooth by a short interval; middle and median teeth contiguous at their bases. Distance from top of posterior median eyes to clypeus 1.4

mm. Palpal segments: femur 3.7 mm., patella 1.8 mm., tibia 2.0 mm., tarsus and claws 2.9 mm. Distance from posterior margin of guide of epigynum to anterior end of furrow of epigynum 1.8 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	6.8	3.7	5.0	4.8	2.8	23.1
II	6.1	3.3	4.2	4.5	2.8	20.9
III	5.3	3.0	3.6	4.5	2.8	19.2
IV	6.6	3.2	5.4	6.6	3.4	25.2

Specimens Recorded: 3—the ♂ and ♀ cotypes and one other female from Austin, Texas.

Geographic Distribution: Known only from the vicinity of Austin, Texas.

Record: TEXAS: Austin—1 ♀ (M.C.Z.).

The most outstanding characteristic of this species is the large size of its genitalia. The epigynum is longer than in any of the other species and the median apophysis of the palpus is strikingly larger and longer than in any other member of the genus. It has already been pointed out that the affinities of *latifrons* are with *missouriensis, fatifera, rogersi, uinticolens,* and *riograndae* —those species in which the ventral edge of the median apophysis describes an open S.

GEOLYCOSA GOSOGA (Chamberlin)

Figs. 31, 68

1925. *Lycosa gosoga* Chamberlin [in part—not *nidifex* Chamberlin 1910]. Bull. Mus. Comp. Zool. Harvard **67**(4):230-231. [Type—a female, M.C.Z. 1,313, from Los Angeles, California].

1936. *Lycosa gosoga* Chamberlin, Chamberlin. Proc. Biol. Soc. Wash. **49**:15-16.

This species resembles *riograndae* in the ventral markings of the legs and differs from it in having a light venter and no dorsal stripe. They also differ in size, *riograndae* being the smaller of the two.

Records: ARIZONA: *Pima Co.:* Tucson, July-August, 1934, Peter Steckler, collector —1 ♀ (A.M.N.H.).

CALIFORNIA: Mohave Desert, near Twenty-nine Palms, August 1939, John A. Anderson, collector—1 ♀ (A.M.N.H.); Mohave Desert, Nov. 1940, J. A. Anderson —2 ♀ ♀, 1 immature (A.M.N.H.).

Chamberlin's description of *Lycosa gosoga* is as follows:

♀. Belonging to the Geolycosa group. Is like *fatifera* in having no light bands on the carapace, the tegument of which is chestnut in color and is clothed with grayish hair, or mostly such. Sternum and coxae of legs yellow. Legs brown, the femora lighter beneath excepting that the patella, tibia, tarsus, and metatarsus of legs I and II are black beneath. The abdomen is gray above, with a vague basal spear-mark. Venter unmarked. The epigynum is in general similar to that of *L. arenicola* but presents a distinct convexity at middle of posterior margin of guide instead of having this margin evenly rounded and less convex; the anterior end of septal piece is slightly bent.

Type.—M. C. Z. 1, 313.

Locality.—California, Los Angeles. One female. The specimens furnishing the basis of the description (Can. ent., **42**, p. 17) were noted as probably from Arizona or southern California and are in the American Museum of Natural History.

[The specimens furnishing the basis of the description (Can. ent., 42, p. 17) are *wrightii*].

GEOLYCOSA RAFAELANA (Chamberlin)

Figs. 57, 58

(?)1908. *Lycosa fatifera* Hentz, Chamberlin [in part]. Proc. Acad. Nat. Sci. Phil., pp. 241-243.

(?)1910. *Lycosa fatifera* Hentz, Chamberlin [in part]. Canadian Entomologist **42**(1):17.

(?)1911. *Geolycosa fatifera* (Hentz), Petrunkevitch [in part]. Bull. Amer. Mus. Nat. Hist. **29**:554.

(?)1912. *Lycosa missouriensis* Banks, Emerton [in part—Utah]. Psyche **19**(2):34.

1928. *Lycosa rafaelana* Chamberlin. In Chamberlin, R. V. and Gertsch, W. J., Proc. Biol. Soc. Wash. **41**:186. [Types: immature specimens from the San Rafael Desert, Emery Co., Utah; in the collection of R. V. Chamberlin].

This species differs from all others occurring west of the Mississippi River in having a black or prevailingly dusky color on legs and body. Most of the males identified here as *rafaelana* from New Mexico are old, dark specimens, apparently discolored by age or preservative. Their palpi resemble those of *wrightii* in general conformation but the median apophysis is longer than in *wrightii* and the palpal tibiae are also relatively longer. They differ from *missouriensis* and *riograndae* in details of the palpi as well as in color pattern.

Records: ARIZONA: 15 miles east of Jacob's Lake, July 17, 1940, W. J. Gertsch —2♀♀, 2 immatures (Gertsch). *Navajo Co.:* Whiteriver, July 8, 1940, W. J. Gertsch —1 juv. (A. M. N. H.)

COLORADO: *Huerfano Co.:* Walsenburg, June 12, 1912, A. G. Vestal "392, from burrows-plains"—1♀ (M.C.Z.).

NEW MEXICO: near Sante Fe, March 23, 1941, H. M. Field—5 immatures (1♀ matured early in May). *San Miguel Co.:* La Trementina—1♂ (M.C.Z.). (?) *Luna Co.:* Deming, July 12, 1917—2♂♂ (Cornell). *Catron Co.:* 19 miles east of Springerville, Ariz., Sec. 25 R21WT1S, 7,000 feet, August 8, 1935, I. J. Cantrall—1♀.

UTAH: (?) *Sevier Co.:* 2 miles east of Glenwood, June 30, 1940, Gertsch and Hook—1 pen. ♂ (A.M.N.H.). (?) *San Juan Co.:* Bluff, May 12, 1933, W. Ivie —1♀, 1 immature (A.M.N.H.). *Wayne Co.:* Torrey, July 11, 1932, Johnson and Gertsch—1♀ (A.M.N.H.).

Chamberlin's description of *Lycosa rafaelana* is as follows:

Female.—This is a member of the burrowing group named Geolycosa by Montgomery. As with other members of this group the females lack median dorsal spines on legs III and IV. Tibiae I and II with a pair of spines at distal end beneath preceded by two spines seriate with the outer of these. It differs from other species of the group, excepting *pikei*, in having all joints of legs I and II black beneath, and it differs from *pikei* in having legs III and IV also black beneath excepting the tarsal joints or, in very young specimens especially, the tibiae may also lack the black color; coxae, femora and patellae of all legs black above and laterally as well as beneath. Carapace dusky brown to nearly solid black, clothed with gray hair. Chelicerae black, clothed with white hair. Sternum solid black. Abdomen also nearly black above and solid black beneath. Lower margin of furrow of chelicera armed with three stout teeth. The epigynum is not fully mature in the types.

Length, 12 mm.

Localities.—San Juan Co.: Big Indian Rock; Emery Co.: San Rafael Desert (type locality). The burrows are common in the sand in several places investigated on the desert, but no male and no wholly mature female was secured.

GEOLYCOSA UINTICOLENS (Chamberlin)

Figs. 32, 59

(?)1908. *Lycosa fatifera* Hentz, Chamberlin [in part]. Proc. Acad. Nat. Sci. Phil., pp. 241-243.

(?)1910. *Lycosa fatifera* Hentz, Chamberlin [in part]. Canadian Entomologist **42**(1):17.

(?)1911. *Geolycosa fatifera* (Hentz), Petrunkevitch [in part]. Bull. Amer. Mus. Nat. Hist. **29**:554.

(?)1912. *Lycosa missouriensis* Banks, Emerton [in part—Utah]. Psyche **19**(2):34.

1936. *Lycosa uinticolens* Chamberlin. Proc. Biol. Soc. Wash. **49**:15-16; fig. 1. [Type—a female from Uintah Mts., Utah, on border of gorge of Green River, near Green Lake, estimated elevation 8,000 feet, 30 July, 1935. Type in collection of R. V. Chamberlin.]

Resembles *missouriensis* Banks in color and markings; differs only in the epigyna of some specimens. Builds a low turret.

Record: Ariz., White Mts., 17 miles northeast of Whiteriver, July 8-10, 1940, Gertsch and Hook, collectors—1 ♂, 18 ♀ ♀, 3 immatures (A.M.N.H.)

Chamberlin's description of *Lycosa uinticolens* is as follows:

Similar to *Lycosa fatifera* Hentz and *L. gosoga* Chamberlin in having the entire ventral surface of the body light colored and quite without dark markings and in having only the last three joints of the first two pairs of legs black, this color embracing the dorsal as well as the ventral surface. Both carapace and dorsal surface of the abdomen decidedly darker than the ventral surface due to a dense coat of black hairs with gray hairs intermixed; carapace also with some appressed brown hairs about the eyes and back along the middle region of the pars cephalica and with some on middle line of anterior part of pars thoracica; clypeal region also with brown hairs. Chelicerae with anterior face covered with appressed brown hairs, its longer setae black. Legs light brown excepting for the black distal segments of the first two pairs. Distal fringes of labium and endites black.

Anterior row of eyes very slightly procurved, equal in length to the second; eyes equidistant, with the medians obviously larger than the laterals. Quadrangle of posterior eyes wider behind than in front (29: 21), and wider behind than long (29: 24). Lower margin of furrow of chelicerae with three teeth, all of which are stout.

The epigynum is of the same general type as in *L. gosoga:* the septal piece strongly bowed ventrad over about the posterior two-thirds of length, the anterior portion strongly narrowed; cross-piece short and nearly straight, not strongly bulging caudad at middle. (See Fig. 1.)

Length of holotype, a female, 16 mm. Length of cephalothorax, 10 mm.; width, 6.4 mm. Length of tibia patella IV, 8 mm.; of tibia patella I, 7.8 mm.

Locality.—Utah: Uintah Mts., on border of gorge of the Green River, near Lake. Estimated elevation, 8,000 ft. 30 July, 1935. Type in author's collection.

Geolycosa riograndae n. sp.

Figs. 15, 16, 35, 52, 82, 92, 100, 110

Holotype: Male, from Edinburg, Hidalgo Co., Texas, October 1934, S. Mulaik, collector; allotype, a female from north of McCook, Hidalgo Co., Texas, Nov. 28, 1937, D. Mulaik, collector: both in the collection of the American Museum of Natural History.

Description of Holotype: In alcohol—Sides of the carapace dusky, dorsal stripe near Cadmium Orange in color; dorsal stripe as wide as posterior eye

quadrangle about midway between the posterior lateral eyes and dorsal groove, from there it narrows gradually in front and behind, extending to between the posterior lateral eyes in front and a short distance back of dorsal groove behind; dorsal stripe blends with the dusky sides of carapace, edges of stripe not being sharply defined; dorsal stripe is covered with a golden pubescence. Dorsum of abdomen near Orange-Buff, conspicuously marked with a black hastate mark in front and a centrally-located black area behind; the latter area has undulating edges and narrows gradually posteriorly, extending to spinnerets. Sides of abdomen dusky, venter black; sternum, endites, and labium somewhat dusky; epigastric region dusky. Coxae near Orange-Buff; femora Orange-Buff below, somewhat darker above; patellae and tibiae I and II and metatarsus I black beneath; tarsi I and II, distal three-fourths metatarsus II, patellae II and IV, and proximal one-third tibia III dark beneath, but lighter than tibia I; other segments of the legs and palpi lighter, but somewhat darker than coxae.

Carapace longer than wide (6.6 mm./4.3 mm.), 2.2 mm. high; width of head 3.1 mm. Posterior eye quadrangle wider than long (1.8 mm./1.4 mm.), eyes of median row larger than those of posterior; median row slightly wider than anterior row (approx. 1.4 mm./1.2 plus mm.). Anterior row of eyes distinctly procurved, eyes evenly spaced, medians somewhat larger than the laterals (approx. 0.3 mm./0.2 mm.). Lower margin of furrow of chelicera with three evenly-spaced, unequal teeth, the one nearest the fang about half as large as the middle one, the middle tooth about half as large as the median. Distance from top posterior median eyes to clypeus 1.0 mm. Palpal segments: femur 2.6 mm., patella 1.3 mm., tibia 1.2 mm., cymbium 2.3 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	5.7	2.6	4.8	4.9	2.7	20.7
II	5.1	2.4	4.0	4.5	2.5	18.5
III	4.5	2.0	3.2	4.5	2.4	16.6
IV	5.8	2.5	5.0	6.4	2.9	22.6

Description of Allotype: In alcohol—Dorsal stripe near Orange-Chrome, sides of carapace dusky, the whole carapace sparsely covered with gray hairs; dorsal stripe almost as wide as posterior eye quadrangle about midway between posterior lateral eyes and dorsal groove, from there narrowing anteriorly to the posterior lateral eyes and posteriorly comes to a point a short distance behind the dorsal groove. Dorsum of abdomen Pale Yellow-Orange laterally, with a black, basal hastate mark and behind this a central black mark which narrows gradually to the spinnerets. Sides of abdomen dusky, venter darker than sides but not black. Coxae, endites, sternum, and femora Pale Yellow-Orange; patellae, tibiae, and metatarsi I and II quite dark, almost black; patellae and tibiae III and IV dusky, lighter than tibia I; the other segments lighter.

Carapace longer than wide (5.0 mm./3.4 mm.), 2.3 mm. high; width of head 2.9 mm. Posterior eye quadrangle wider than long (1.6 mm./1.2 mm.), median eyes larger than laterals (0.6 mm./0.4 plus mm.); posterior median row slightly wider than anterior (1.3 mm./1.2 mm.). Anterior row of eyes

procurved, eyes evenly spaced, medians larger than laterals (approx. 0.3 mm./ 0.2 mm.). Lower margin of furrow of chelicera with three equally spaced teeth, tooth nearest the fang smaller than the other two which are of the same size. Distance from top posterior median eyes to clypeus 0.9 mm. Distance from posterior edge of epigynum to anterior end of furrow of epigynum 0.7 mm. Palpal segments: femur 1.9 mm., patella 0.9 mm., tibia 1.0 mm., tarsus and claws 1.6 mm. Legs 4123.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	3.5	1.9	2.8	2.6	1.6	12.4
II	3.1	1.7	2.3	2.4	1.6	11.1
III	2.8	1.5	1.8	2.4	1.5	10.0
IV	3.7	1.8	3.1	3.7	1.9	14.2

Specimens Recorded: 8—2 ♂♂, 4 ♀♀, 2 immatures.

Geographic Distribution: Known only from Zapata and Hidalgo counties in southern Texas.

Records: TEXAS: *Hidalgo Co.:* Edinburg, Oct. 1934, S. Mulaik—1 ♂ *(holotype)*, and 2 immatures; north of McCook, Nov. 28, 1937, D. Mulaik—4 ♀♀ *(allotype* and 3 *paratypes); Zapata Co.:* Arroyo Loma Blanca, Zapata, Sept. 20, 1935, S. Mulaik —1 ♂ *(paratype)*. All the above specimens are from the collection of the American Museum of Natural History.

Remarks: This species is one of the smallest of the *Geolycosas*. It differs from *missouriensis* and *ornatipes* in the markings of the legs and in the genitalia; the palpi appear to be closest to those of *fatifera*, but the markings are quite different from those of that species.

The *allotype* is smaller than two of the female *paratypes*, but all four females recorded here are quite similar in appearance. The male *paratype* is similar in size to the *holotype* but differs slightly in markings—the venter of the former specimen is much lighter than that of the *holotype*, there being only a small dusky area just behind the epigastric furrow.

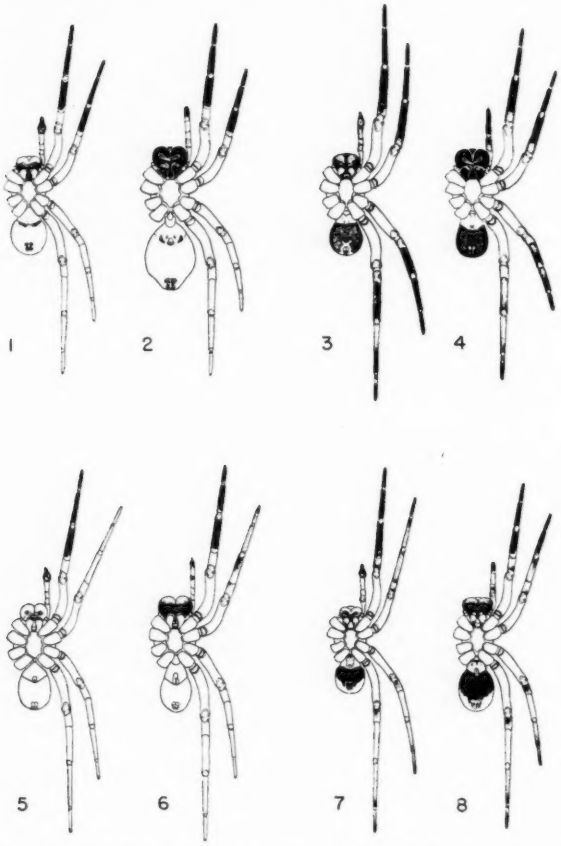

PLATE 1.—Ventral Pattern of Body and Legs. Figs. 1-2. *G. missouriensis* (Banks). 1. ♂. Mich., Cheboygan Co. (alcoholic). Pigmented areas as shown. 2 ♀. Mich., Cheboygan Co. (alcoholic). Pigmented areas as shown; shape of abdomen due to shrinkage.

Figs. 3-4. *G. fatifera* (Hentz). 3. ♂. Fla., Alachua Co. (pinned). Venter quite dark but not jet black; legs as shown. 4. ♀. Fla., Alachua Co. (pinned). Venter quite dark but not black; legs as shown.

Figs. 5-6. *G. latifrons* Montgomery. 5. ♂ type. Texas, Austin. (alcoholic). Tibia and metatarsus quite dark but not jet black as shown. 6. ♀ type. Texas, Austin. (alcoholic). Tibia and metatarsus quite dark but not jet black as shown.

Figs. 7-8. *G. wrightii* (Emerton). 7. ♂. Ind., Dune Acres, (pinned). Tibia, metatarsus, and tarsus very dark, but not black. 8. ♀. Ind., Dune Acres, (pinned). Areas shown in black are quite dark but not black.

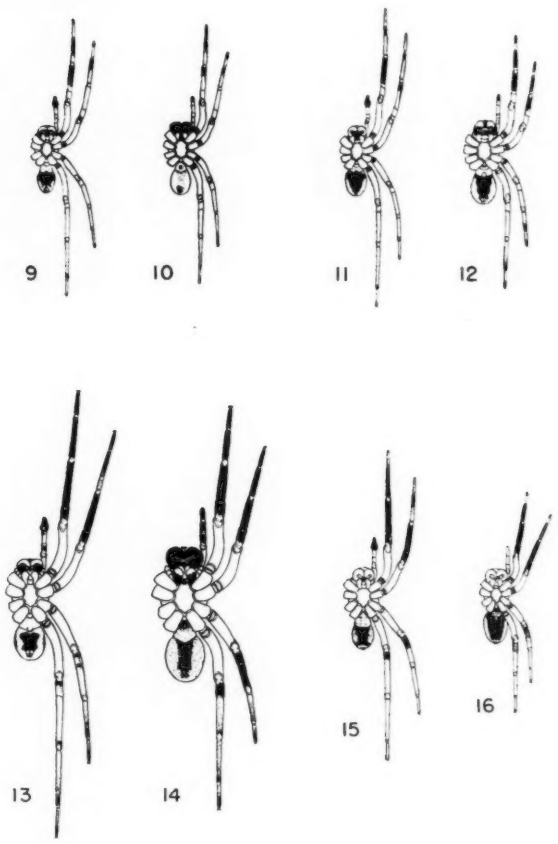

PLATE 2.—Ventral Pattern of Body and Legs. Figs. 9-10. *G. escambiensis*, n. sp. 9. ♂. Fla., Santa Rosa Island, (pinned). As shown. 10. ♀. Fla., Santa Rosa Island, (alcoholic). As shown.

Figs. 11-12. *G. ornatipes* (Bryant). 11. ♂. Fla., Alachua Co., (pinned). Venter very dark but not black. 12. ♀. Fla., Alachua Co., (pinned). Venter dusky but not black.

Figs. 13-14. *G. turricola* (Treat). 13. ♂. Mass., Tyngsboro, (pinned). Areas shown in black have brownish cast, are quite dark, but not black. 14. ♀. N. C., Burlington, (pinned). As shown.

Figs. 15-16. *G. riograndae*, n.sp. 15. ♂. Texas, Hidalgo Co., (alcoholic). As shown. 16. ♀. Texas, Hidalgo Co., (alcoholic). As shown.

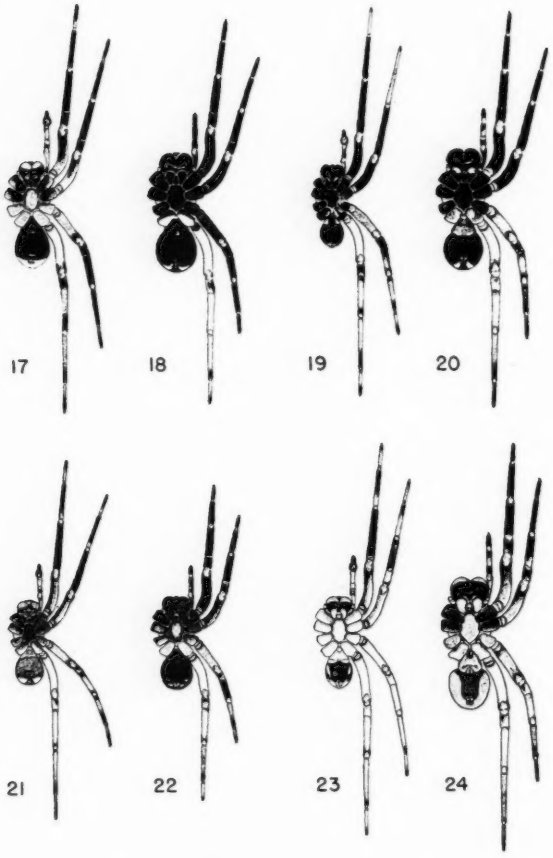

PLATE 3.—Ventral Pattern of Body and Legs. Figs. 17-18. *G. hubbelli*, n.sp. 17. ♂. Fla., Marion Co., (pinned). Venter with a grayish cast instead of jet black as shown; femur IV with a reddish cast. 18. ♀. Fla., Marion Co., (pinned). Non-pigmented areas are a deep chestnut; otherwise as shown.

Figs. 19-24. *G. micanopy*, n. sp. 19. ♂. Fla., Clay Co., (pinned). Pigmented areas as shown; legs III and IV with a reddish cast. 20. ♀. Fla., Alachua Co., (pinned). Venter quite dark but not black; legs III and IV with a reddish cast. 21. ♂. Fla., Volusia Co., (pinned). Pigmented areas as shown. 22. ♀. Fla., Dade Co., (pinned). Pigmented areas as shown. 23. ♂. Fla., Sarasota Co., (pinned). Venter dark but not black. 24. ♀. Fla., Lee Co., (pinned). Pigmented areas as shown.

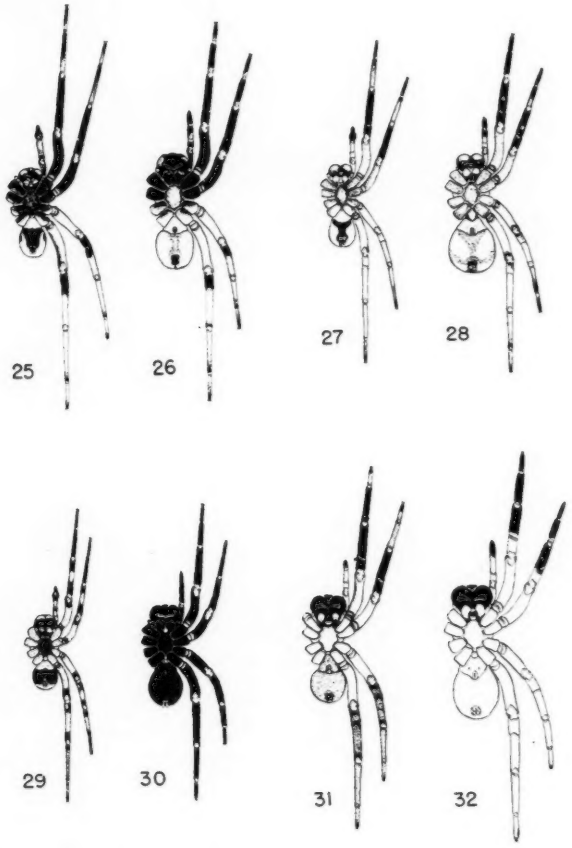

PLATE 4.—Ventral Pattern of Body and Legs. Figs. 25-26. *G. patellonigra*, n. sp. 25. ♂. Fla., Levy Co., (pinned). Venter dark but not jet black as shown. 26. ♀. Fla., Levy Co., (pinned). Pigmented areas as shown.

Figs. 27-28. *G. pikei* (Marx). 27. ♂. Conn., New Haven, (pinned). Venter dark, not black. 28. ♀. Conn., New Haven, (pinned). Pigmented areas as shown.

Fig. 29. *G. rogersi*, n. sp. 29. ♂. Fla., Alachua Co., (pinned). Pattern due to light pubescence over black body surface. 30. ♀. Fla., Alachua Co., (pinned). Body black, covered with light grey pubescence. Fig. 31. *G. gosoga* (Chamberlin), ♀. California, Mohave Desert, (alcoholic). Pigmented areas as shown.

Fig. 32. *G. uinticolens* (Chamberlin), ♀. Ariz., White Mts., (alcoholic). Pigmented areas as shown.

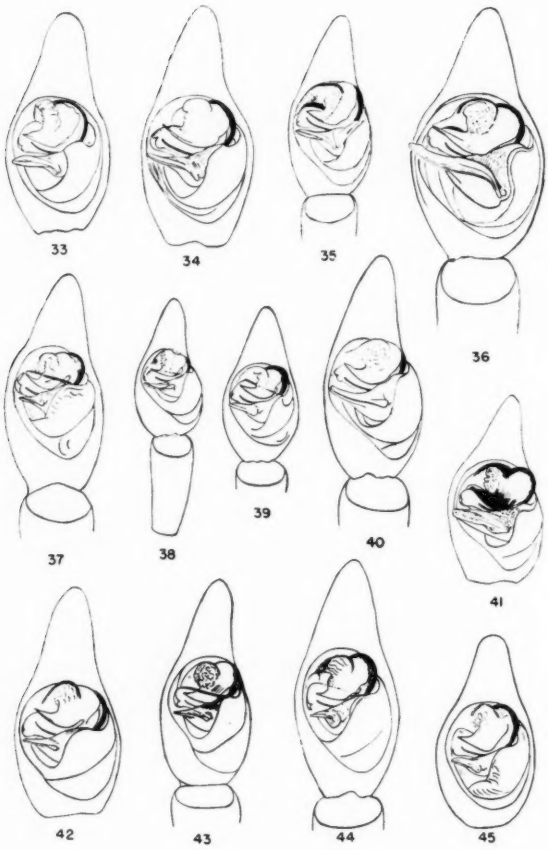

PLATE 5. Figs. 33-45.—Male Palpi. 33. *G. fatifera* (Hentz). Fla., Alachua Co. 34. *G. missouriensis* (Banks). 35. *G. riograndae*, n. sp. Texas, Zapato. 36. *G. latifrons* Montgomery, *type*. Texas, Austin. 37. *G. hubbelli*, n. sp., holotype. Fla., Marion Co. 38. *G. ornatipes* (Bryant). Fla., Alachua Co. 39. *G. escambiensis*, n. sp., *holotype*. Fla., Santa Rosa Island. 40. *G. micanopy*, n. sp., *holotype*. Fla., Alachua Co. 41. *G. rogersi*, n. sp., *paratype*. Fla., Alachua Co. 42. *G. turricola* (Treat). Md., Baltimore. 43. *G. wrightii* (Emerton). Ind., Dune Acres. 44. *G. patellonigra*, n. sp., *holotype* Fla., Levy Co. 45. *G. pikei* (Marx).

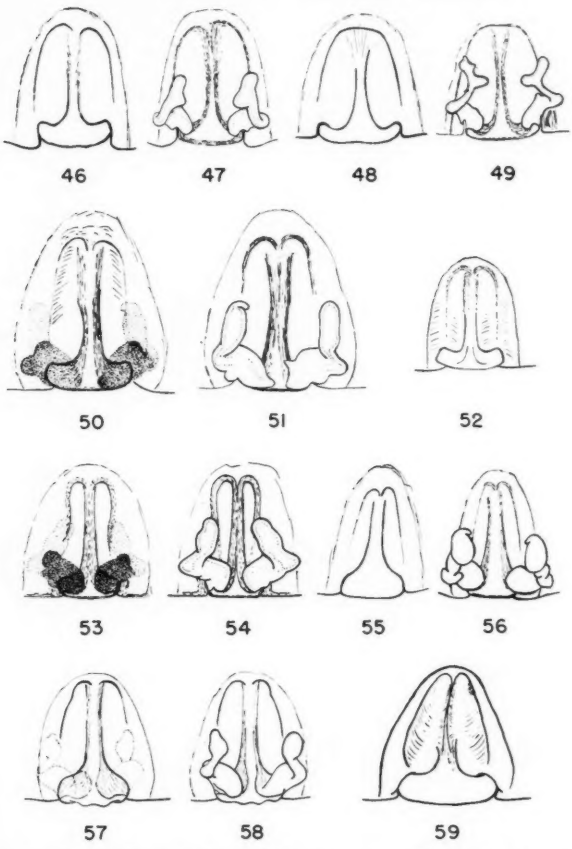

PLATE 6.—Female Epigyna. Figs. 46-49, *G. falifera* (Hentz). 46. External view. Fla., Alachua Co. 47. Internal view. Fla., Alachua Co. 48. External view. Fla., Dade Co. 49. Internal view. Fla., Dade Co.

Figs. 50-51. *G. missouriensis* (Banks). 50. External view. Tex., Bryan. 51. Internal view. Tex., Bryan.

Fig. 52. *G. riograndae*, n. sp., external view. Tex., Hidalgo Co.

Figs. 53-54. *G. turricola* (Treat). 53. External view. N. J., Lakehurst. 54. Internal view. N. J., Lakehurst.

Figs. 55-56. *G. wrightii* (Emerton). 55. External view. Ill., Chicago. 56. Internal view. Ill., Chicago.

Figs. 57-58. *G. rafaelana* (Chamberlin). 57. External view. New Mex., Catron Co. 58. Internal view. New Mex., Catron Co.

Fig. 59. *G. uinticolens* (Chamberlin), external view. Ariz., White Mts.

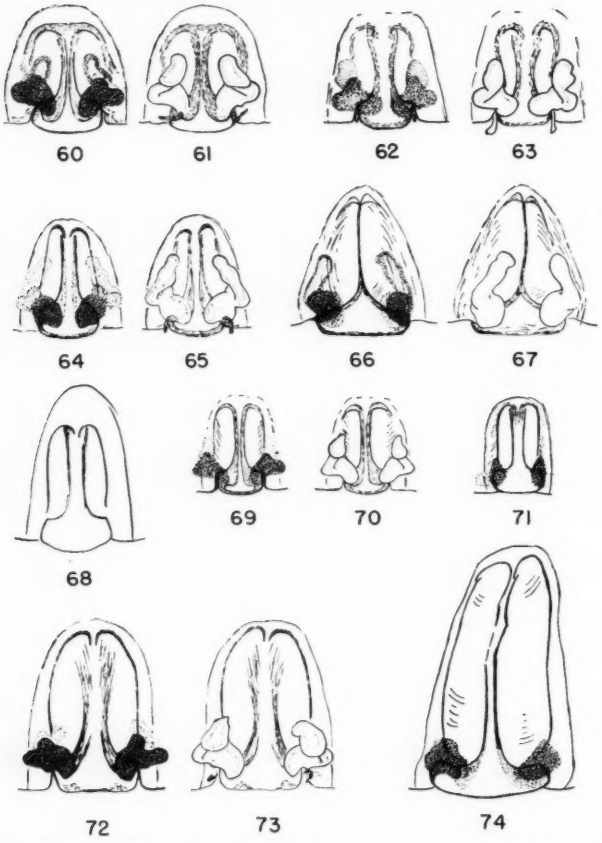

PLATE 7. Female Epigyna. Figs. 60-61. *G. patellonigra*, n. sp. 60. External view. Fla., Levy Co. 61. Internal view. Fla., Levy Co.

Figs. 62-63. *G. pikei* (Marx). 62. External view. N. J., Lakehurst. 63. Internal view. N. J., Lakehurst.

Figs. 64-65. *G. hubbelli*, n. sp. 64. External view. Fla., Marion Co. 65. Internal view. Fla., Marion Co.

Figs. 66-67. *G. rogersi*, n. sp. 66. External view. Fla., Alachua Co. 67. Internal view. Fla., Alachua Co.

Fig. 68. *G. gosoga* (Chamberlin), external view. Cal., Mohave Desert.

Figs. 69-70. *G. ornatipes* (Bryant). 69. External view. Fla., Alachua Co. 70. Internal view. Fla., Alachua Co.

Fig. 71. *G. escambiensis*, n. sp., external view. Allotype, Fla., Santa Rosa Island.

Figs. 72-73. *G. micanopy*, n. sp. 72. External view. Fla., Alachua Co. 73. Internal view. Fla., Alachua Co.

Fig. 74. *G. latifrons* Montgomery, external view. *Type*. Texas, Austin.

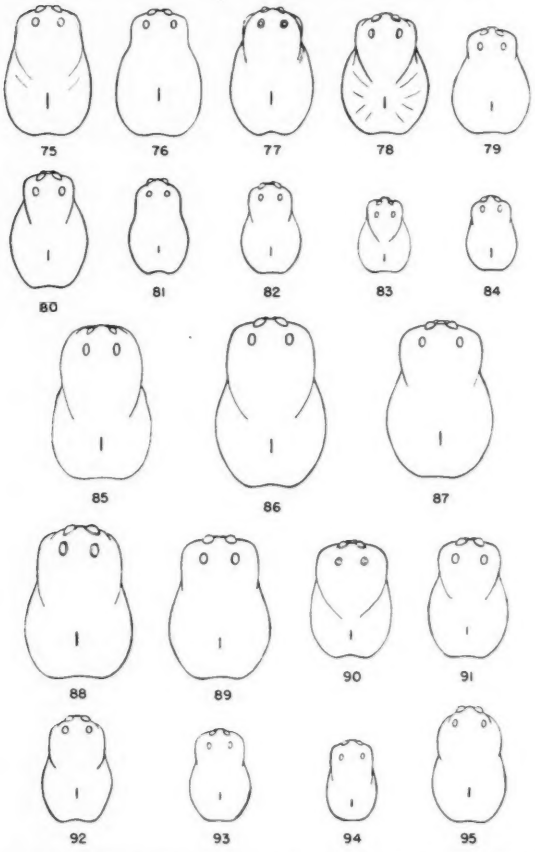

PLATE 8. Figs. 75-95—Outline Drawings of Carapace—Dorsal View. 75. *G. fatifera* (Hentz), ♂. Fla., Alachua Co. 76. *G. missouriensis* (Banks), ♂. Mich., Douglas Lake. 77. *G. hubbelli*, n. sp., ♂ holotype. Fla., Marion Co. 78. *G. patellonigra*, n. sp., ♂ *holotype*. Fla., Levy Co. 79. *G. pikei* (Marx), ♂. N. Y., L. I., Jamaica. 80. *G. wrightii* (Emerton), ♂. Ind., Dune Acres. 81. *G. rogersi*, n. sp., ♂ paratype. Fla., Alachua Co. 82. *G. riograndae*, n. sp., ♂. Texas, Zapato. 83. *G. escambiensis*, n. sp., ♂ *holotype*. Fla., Santa Rosa Island. 84. *G. ornatipes* (Bryant), ♂. Fla., Alachua Co. 85. *G. fatifera* (Hentz), ♀. Fla., Alachua Co. 86. *G. missouriensis* (Banks), ♀. Texas, Bryan. 87. *G. turricola* (Treat), ♀. N. J., Ramsey. 88. *G. patellonigra*, n. sp., ♀ allotype. Fla., Levy Co. 89. *G. pikei* (Marx), ♀. N. J., Matawan. 90. *G. hubbelli*, n. sp., ♀ *allotype*. Fla., Marion Co. 91. *G. wrightii* (Emerton), ♀. Ill., Kankakee Co. 92. *G. riograndae*, n. sp. ♀. Tex., Hidalgo Co. 93. *G. ornatipes* (Bryant), ♀. Fla., Alachua Co. 94. *G. escambiensis*, n. sp. ♀. Fla., Santa Rosa Island. 95. *G. rogersi*, n. sp. ♀ *allotype*. Fla., Alachua Co.

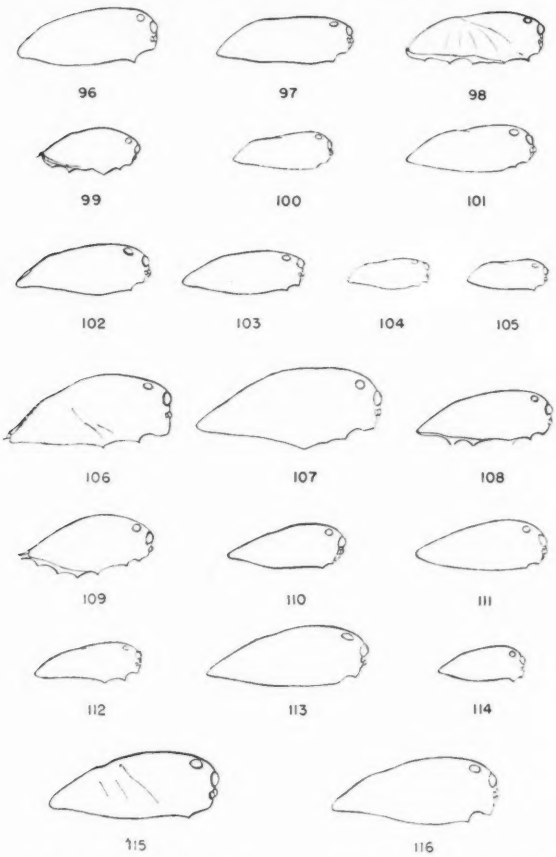

PLATE 9. Figs. 96-116.—Outline Drawings of Carapace—Lateral View. 96. *G. fatifera* (Hentz). ♂. Fla., Alachua Co. 97. *G. missouriensis* (Banks), ♂. Mich., Douglas Lake. 98. *G. hubbelli*, n. sp., ♂ *holotype*. Fla., Marion Co. 99. *G. rogersi*, n. sp., ♂ *paratype*. Fla., Alachua Co. 100. *G. riograndae*, n. sp., ♂. Texas, Zapato. 101. *G. wrightii* (Emerton), ♂. Ind., Dune Acres. 102. *G. patellonigra*, n. sp., ♂ *holotype*. Fla., Levy Co. 103. *G. pikei* (Marx), ♂. N. Y., L. I., Jamaica. 104. *G. escambiensis*, n. sp., ♂ *holotype*. Fla., Santa Rosa Island. 105. *G. ornatipes* (Bryant), ♂. Fla., Alachua Co. 106. *G. fatifera* (Hentz), ♀. Fla., Alachua Co. 107. *G. missouriensis* (Banks), ♀. Texas, Bryan. 108. *G. hubbelli*, n. sp., ♀ *allotype*. Fla., Marion Co. 109. *G. rogersi*, n. sp. ♀ *allotype*. Fla., Alachua Co. 110. *G. riograndae*, n. sp. ♀. Texas, Hidalgo Co. 111. *G. wrightii* (Emerton), ♀. Ill., Kankakee Co. 112. *G. ornatipes* (Bryant), ♀. Fla., Alachua Co. 113. *G. pikei* (Marx), ♀. N. J. Matawan. 114. *G. escambiensis*, n. sp., ♀. Fla., Santa Rosa Island. 115. *G. patellonigra*, n. sp., ♀ *allotype*. Fla., Levy Co. 116. *G. turricola* (Treat), ♀. N. J., Ramsey.

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The Subfamily Entocytherinae, a New Subfamily of Fresh-Water Cytherid Ostracoda, with Descriptions of Two New Species of the Genus Entocythere[1, 2]

C. Clayton Hoff

While making an ecological and taxonomic study of the ostracods of Illinois, the writer found the crayfishes of east central Illinois to be hosts of two species of Entocythere, both of which are new.

Little attention has been given this group of ostracods although Marshall described the genotype, *Entocythere cambaria*, as early as 1903. The only other species originally described as belonging to this genus are *E. donnaldsonensis* Klie 1931 and *E. columbia* Dobbin 1941. In addition Sars (1926), however, published the description of an Entocythere species from Canada under the designation, *Cytherites insignipes*. Since the American genus Entocythere Marshall 1903 and the Continental European genus Sphaeromicola Paris 1916 form a natural group, the writer proposes herein to include these two genera in the subfamily Entocytherinae of the family Cytheridae.

The writer wishes to thank Prof. H. J. Van Cleave for his kind advice during the course of the investigation and for his careful reading of the manuscript.

Method

In collecting ostracods of the genus Entocythere from the gills of crayfishes, the ostracods will leave the gills of the host if the crayfishes are placed in a vessel containing 95% ethyl alcohol. The ostracods may be removed from the sediment in the bottom of the container. That this method insures the removal of all the ostracods is shown by the complete absence of ostracods from the host gills after the treatment with alcohol. In order to keep accurate host records, each species of crayfish was placed in an individual container.

The most satisfactory method of preparing individuals of Entocythere for study is to stain them in acid fuchsin, dehydrate in the alcohol series, and mount in diaphane from absolute alcohol. Staining and dehydrating may be carried out easily in LeFevre embryological watch glasses or other small containers in which the material is carried through various solutions by adding or removing the solution with a finely pointed pipette. The material is removed to water from alcohol and is washed in a small amount of 1/50-N solution of hydrochloric acid for one or a few minutes. After pipetting off the acid

1 A contribution from the Zoological Laboratory of the University of Illinois.

2 This study was aided by a grant from the American Association for the Advancement of Science through the Illinois State Academy of Science.

water, a 0.5% aqueous solution of acid fuchsin is placed in the watch glass and the animals left in this from one to five hours, the time apparently varying with the recency of molting. After staining, the acid fuchsin solution is removed and the material washed rapidly several times in a 1/50-N solution of hydrochloric acid. To avoid destaining, washing must not be done in neutral or alkaline water. The stained ostracods are then run through the alcohol series to absolute alcohol and mounted in diaphane. Since the Entocythere are laterally compressed, no support is needed to keep the cover from resting on the preparation. In some individuals, the shell should be removed and the appendages separated from the body with finely pointed needles. This is best carried out in a drop of the mounting medium. In lieu of diaphane, it is possible to clear in benzol or xylol and mount the organism in balsam.

Biology of the Entocytherinae

While the reported species of the European genus Sphaeromicola live commensally on isopods and amphipods, most and probably all known species of Entocythere are associated with crayfishes. Marshall (1903) reported *Entocythere cambaria* from crayfishes of the genus Cambarus, but Klie (1931) found *E. donnaldsonensis* unassociated with crayfishes. However, the structural adaptations of this latter species suggests habits not found in a free-living ostracod. Sars (1926) did not know the location or ecology of his *Cytherites insignipes* from Canada. The two species found by the present writer in Illinois are distinctly associated with various species of Cambarus. While it is definitely established that the Sphaeromicola species of Europe live as commensals, there is some question regarding the association between ostracod and crayfish in the genus Entocythere. Marshall (1903) believed that *E. cambaria* was parasitic and fed upon blood circulating in the branchiae of the host. His deduction is based on the belief that the homogeneous mass of material in the intestine of the ostracod is the blood of the host. This is not valid proof, however, since a homogeneous food mass is found as well in many free-living ostracods. Considered morphologically, the mouth parts may be used in two ways: (1) for straining out particulate organic material from the water as in many free-living species and (2) for rasping off epidermal tissue for ingestion along with mucus from the gills. That the Entocythere species do feed on material in the water is evidenced by the finding of diatoms and other particulate organic materials in the gut. That the organisms are not strictly parasitic is also shown by the fact that they often for some reason leave the host. Individuals have been found by the writer in the water of crayfish burrows and by Klie (1931) in Indiana cave waters. All of the Entocythere species are probably commensal, but at the very most, if parasites at all, are only facultative.

Certain important problems relative to the manner of infestation and host specificity are also undecided. Marshall (1903) held the opinion that in *E. cambaria* infestation occurs during copulation or when an ostracod leaves its host for some reason and finds another. The dark sheltered places where crayfishes commonly hide are well suited for this transfer. The lack of host

specificity is some indication of the transfer of infestations other than during copulation since, if transfer occurred only during mating, infestation would probably show some host specificity. At the best, transfer is probably not very easy or frequent as partially shown by the fact that young crayfish in which molting is often repeated are seldom infested while old individuals have a high incidence of infestation.

Definite host specificity is not indicated in the writer's collections. Similar to the conditions found by Marshall (1903) in Wisconsin, a single species of Entocythere may be found on several species of crayfish. A lack of host specificity is probably to be expected in all of the organisms living in the gill chamber of crayfishes. This lack of host specificity has been shown also by Goodnight (1940) in the Branchiobdellid worms.

The Subfamily Entocytherinae subfam. nov. and Descriptions of Two New Entocythere Species

Class CRUSTACEA
Order OSTRACODA
Suborder PODOCOPA *s. str.*
Family *Cytheridae*
Subfamily **Entocytherinae** subfam. nov.

Type of subfamily: Genus Entocythere Marshall 1903.

A subfamily of the family Cytheridae. Shell reniform to elliptical, thin, chitinous, laterally compressed, with the valves little if any unequal; surface of valves without protuberances or papillae, occasionally with slight sculpturing and a few hairs. The eyes, when present, are fused. The antennules consist of six or seven podomeres with shortened swimming setae; antennae of four podomeres, often with the penultimate podomere subdivided, and armed distally with two or three claws. Mandible well developed; all of the podomeres of the palp except the distal one often fused together. Maxilla variable in different species; consisting of a palp and not more than one masticatory process; podomeres of palp often fused together; respiratory plate may be wanting. Thoracic legs similar, all prehensile, each terminating in a large curved claw. A subfamily containing two genera, Entocythere Marshall 1903 from North America and Sphaeromicola Paris 1916 from Europe.

Genus SPHAEROMICOLA Paris 1916

Genotype: *Sphaeromicola topsenti* Paris 1916.

A genus of the subfamily Entocytherinae. Distal podomere of the mandibular palp often spatulate in shape; the respiratory plate of the maxilla wanting; the masticatory lobes of the maxilla vestigial. The penis with a shortened base usually having a highly convex posterior margin. Commensals of Isopoda and Amphipoda; fresh-water and marine; Europe.

Three species are recorded in the literature as belonging to this genus:

1. *Sphaeromicola topsenti* Paris 1916, a commensal of the fresh-water isopod *Caecosphaeroma burgundum* Dollfus and perhaps also *C. virei* Dollfus; France.

2. *Sphaeomicola stammeri* Klie 1930, a commensal of numerous species of fresh-water isopods belonging to the genera Monolistra and Microlistra; southern Europe.

3. *Sphaeromicola dudichi* Klie 1938, a commensal of the marine boring amphipod *Chelura terebrans* Philippi; Gulf of Naples.

Genus ENTOCYTHERE Marshall 1903

Syn.: *Cytherites* Sars 1926.

Genotype: *E. cambaria* Marshall 1903.

A genus of the subfamily Entocytherinae. Distal podomere of the mandible never spatulate; respiratory plate of the maxilla well developed with at least twelve setae; maxilla with a fleshy masticatory lobe (except in *E. insignipes* where the masticatory lobe is unreported either through an oversight of the describer or by its actual absence) ending in setae. The penis with a base elongate or elliptical with only a relatively slightly curved posterior margin. Commensals (or possibly facultative parasites) on crayfishes of the genus Cambarus; North America.

Two subgenera, Entocythere Marshall 1903 and Cytherites Sars 1926, may be recognized.

KEY TO THE SUBGENERA AND SPECIES OF THE GENUS ENTOCYTHERE

1a. Length of shell approximately 0.60 mm.; antenna of the female with three distal claws (Fig. 4) ..... Subgenus Entocythere Marshall 1903..... 2

b. Length of shell 0.60 mm. or less; only two distal claws on the antenna of the female (Fig. 10) ..... Subgenus Cytherites Sars 1926..... 3

2a. The distal podomere of the antennule little more than three times as long as wide; antenna composed of four podomeres; the mandibular palp of four distinct podomeres ..... *E. (E.) cambaria* Marshall 1903

b. The distal podomere of the antennule about five times as long as wide; antenna composed of five apparent podomeres through a division of the penultimate one; podomeres of the mandibular palp fused ..... *E. (E.) illinoisensis* sp. nov.

3a. Distal margin of penultimate podomere of the antennule with several long setae; distal podomere of maxillary palp well separated from basal portion ..... *E. (C.) insignipes* (Sars 1926) comb. nov.

b. Penultimate podomere of antennule without setae; distal podomere of maxillary palp not separated but fused with other podomeres (Fig. 11) 4

4a. Antenna of male with two large distal claws; the penultimate podomere of each thoracic leg without a distal seta..... *E. (C.) donnaldsonensis* Klie 1931

b. Antenna of male with two large and one relatively small distal claws (fig. 12); the penultimate podomere of each thoracic leg with a single distal seta 5

5a. The ventral and posterior margins of the shell united to form a pronounced projection; mandibular palp of four distinct podomeres ..... *E. (C.) columbia* Dobbin 1941

b. Shell with the ventral posterior angle evenly rounded; basal three podomeres of the mandibular palp fused together ..... *E. (C.) copiosa* sp. nov.

Subgenus ENTOCYTHERE Marshall 1903

Type species: *E. cambaria* Marshall 1903.

Length of shell about 0.6 mm.; antennules with six podomeres; antenna of female with three distal claws; less than fifteen setae in respiratory plate of maxilla.

Two species known: *E. cambaria* Marshall 1903 from crayfishes of Wisconsin and *E. illinoisensis* sp. nov. from crayfishes of Illinois. *E. cambaria* has also been reported from crayfishes of North Carolina by Allen (1933) but, as far as known to the present writer, her identification has not been verified.

Entocythere illinoisensis sp. nov.

Figs. 1-8

Type locality: East central Illinois.

Description of the female: An ostracod of the genus Entocythere. Shell (Fig. 2) from the side subelliptical; dorsal margin forms a high even arch passing into posterior and anterior margins without interruption; anterior end so narrowly rounded that the shell appears pointed, the posterior end more broadly rounded; ventral margin nearly straight but showing a slight sinuation anterior to the center. Much of the surface (Fig. 3) of the shell is leather-like and transparent; the color appears slightly yellowish-brown in alcohol preserved material. The eyes are fused and are located far anteriorly where they may be seen through the shell as intensely black spheres (Fig. 2-E). There are a very few short, straight hairs along the anterior, posterior, and ventral margins. The greatest height is about three-fifths of the length and is located a little posterior to the center of the shell. From above (Fig. 1): greatest width equal to one-half of the length and located just posterior to the middle of the shell. The sides from above appear gently arched; the anterior end more pointed than the posterior. The valves appear equal in size. The average dimensions for the shell are 0.63 mm. in length; 0.37 mm. in height; and 0.19 mm. in width.

The antennules are long and slender and are composed of six podomeres. The distal four podomeres are subequal in length, each being more slender than the next more proximal one. The distal podomere has a length equal to about five times the width. The second podomere bears a single seta on the inner distal margin; the third bears two setae; and the antepenultimate has five setae around the distal margin. On the penultimate podomere, setae are wanting. The ultimate podomere bears five distal setae which have a length equal to two or two and one-half times the length of the ultimate podomere. Antenna of five apparent podomeres through a division, which is usually distinct, of the penultimate podomere. The antenna is very stout; the second podomere has a distal width but little less than its length. The second podomere bears a very stout spine on the posterior distal corner; the tip of this spine reaches beyond the distal margin of the next distal apparent podomere. The distal margin of the posterior portion of the penultimate podomere bears

two setae. The longest of these has a length equal to the width of the podomere taken at the base of the setae, the other is one-half as long. The anterior division of the penultimate podomere bears a stout spine anterior of the center of the ventral or posterior margin. Terminally the antenna has three unequal claws (Fig. 4), a short scale-like appendage, and an inarticulate spur not always discernible. The last two structures are on the outside, ventral corner of the appendage; the smallest of the three end claws is on the medial side and is transparent and small.

The base of the mandible is stout; the podomeres of the palp are fused except the utlimate one which is but little longer than wide and bears distally a stout claw-like toothed spine and two small setae. The basal portion of the palp represents several fused podomeres and has a single distal seta, a seta on the side near the distal end, and another near the base. The respiratory plate of the mandible is reduced to two long and one short setae. The maxilla has a respiratory plate with thirteen plumose setae. A single masticatory process is present and bears distally two slender curved spines. The palp (Fig. 5-M) is unjointed and bears a long, basally curved but distally straight spine. A slender distal spine is found companion to the first and a second is found a short distance proximal. The masticatory process (Fig. 5-P) and palp are fleshy in appearance.

The first pair of thoracic legs (Fig. 6) are each composed of four podomeres. At the distal posterior end of the first podomere are found two setae; a single seta may be found on the posterior margin of the second and third podomeres a short distance proximal from the distal end in the second podomere and at the distal margin in the third podomere. Each leg has a terminal claw which is in the form of a semicircle, the inside of the semicircle being directed anteriorly and bearing a number of exceptionally long teeth. The second pair of legs are longer than the first; the third pair longer than the second. The legs of all three pairs are alike morphologically except that in the second and third pairs, the distal anterior corner of the first podomere bears a single seta instead of a pair.

Description of the male: The shell of the male is more elongate than that of the female but has the same general shape. The length is slightly less than in the female, ranging in the individuals examined from 0.54 to 0.61 mm., while the height only averages 0.28 to 0.29 mm. The appendages of the male are in general like those of the female with the exception of the antenna in which the terminal claws of the male (Fig. 7) are modified by having the dorsal or anterior claw peculiarly shaped with a straight distal portion fitting accurately against the anterior surface of the other large claw. A third and smaller claw is present but the scale-shaped structure described for the female is absent. The base of the penis is elliptical, rounded distally, and undivided. The penis (Fig. 8) bears three appendages. The first (Fig. 8-A) is very chitinous and is L-shaped, the dorsal side of the base being roughened with the point directed anteriorly on the penis *in situ*. This chitinous appendage is probably used to grasp the female organ. The second appendage (Fig. 8-B) is long, slender, and little chitinized. It bears distally a small spine and func-

tions either as an organ carrying the distal end of the vas deferens (Marshall. 1903) or it is tactile (Klie, 1931). The third (Fig. 8-C) and the most dorsal appendage is short and bears distally two small setae. This is considered by Klie (1931) to be the vestige of the furca.

Remarks: E. illinoisensis bears a closer resemblance to *E. cambaria* than to any other species of Entocythere. The two species resemble each other in size, number of podomeres in the antennule, number of end claws in the antenna, and the number of rays in the respiratory plate of the maxilla. The main differences are that *E. illinoisensis* has five podomeres in the antenna and two podomeres in the mandibular palp while *E. cambaria* has four podomeres in the antenna and four in the mandibular palp. There is also considerable and distinctive differences in the shape of the penis in the two species.

Ecology: This species seems to be rare in comparison to the numbers which may be found of the species *E. copiosa* sp. nov. The crayfish host records for *E. illinoisensis* as represented in the writer's collections are as follows:

Cambarus propinquus Girard	5 collections
Cambarus virilis Hagen	2 collections
Cambarus immunis Hagen	1 collection

E. illinoisensis sp. nov. may be found associated with *E. copiosa* sp. nov. simultaneously on the same host animal.

Distribution: E. illinoisensis sp. nov. is known only from Vermilion, Crawford, and Champaign Counties, Illinois.

The holotype (female) and allotype (male) of this species will be deposited in the U. S. National Museum. The paratypes will be placed in the collections of H. J. Van Cleave, Arthur G. Humes, and the writer.

Subgenus CYTHERITES Sars 1926

Type species: *Cytherites insignipes* Sars 1926.

A subgenus of the genus Entocythere. Length of shell 0.6 mm. or less; antennule with six or seven podomeres; antenna of female with two end claws; more than fifteen setae in the respiratory plate of the maxilla as far as known.

Four species are known to belong to this subgenus: *E. (C.) insignipes* Sars 1926 (ecology unknown); *E. (C.) donnaldsonensis* Klie 1931 from an Indiana cave (not on crayfish when taken); *E. (C.) columbia* Dobbin 1941 from Washington crayfishes; and *E. (C.) copiosa* sp. nov. from Illinois crayfishes.

Entocythere copiosa sp. nov.

Figs. 9-13

Type locality: Illinois.

Description of the female: An ostracod of the genus Entocythere. Shell (Fig. 9) from the side, reniform; dorsal margin evenly arched; posterior end

broadly rounded; anterior end more narrowly rounded; ventral margin with a distinct sinuation a little anterior to the center. Greatest height posterior to the center and measuring about five-ninths of the length. The eye is usually conspicuous. The shell is greatly compressed. The surface is smooth and practically hairless. The length of the shell varies from 0.38 to 0.44 mm.; the height from 0.21 to 0.24 mm.

The antennules of six podomeres are long and slender; the penultimate podomere without setae; ultimate podomere with a length six times the width; terminal setae five in number and with a length considerably more than twice the length of the ultimate podomere. The antenna with the penultimate podomere either distinctly or indistinctly divided. The antenna has two terminal claws (Fig. 10) without any indication of a third claw or any accessory distal structure. The teeth of the smaller or more anterior of the two claws are weak. The posterior margin of the divided penultimate podomere (Fig. 10-P) bears distally a pair of nearly equal setae; the posterior margin of the anterior one-half bears a single seta near the distal end. The first podomere of the endopodite bears a stout seta reaching well beyond the center of the apparent penultimate podomere. The mandible is slender with the outer tooth of the base widened and distally comb-like. The palp with the podomeres fused except the last which bears distally a stout curved spine and a slender seta about as long as the spine. On the distal inner corner of the fused basal podomeres of the palp is a seta extending beyond the distal margin of the ultimate podomere. The respiratory plate is reduced and consists of a small fleshy plate about as wide as long and bearing two long and one short setae. The maxilla has a respiratory plate with eighteen plumose setae. The podomeres of the maxillary palp are fused; and the palp (Fig. 11-M) bears distally a very gently curved spine-like seta and a much straighter, more slender, and slightly shorter seta. The single masticatory process (Fig. 11-P) bears two distal, nearly equal, slender and little curved setae. The thoracic legs present no features of taxonomic importance; there is a spine near the distal anterior corner of the penultimate and the antepenultimate podomeres.

Description of the male: Shell similar to that of the female except that the ventral margin is often straight and the shell is slightly smaller. The appendages of the male are like those of the female except that the antenna (Fig. 12) has three distal claws, two of which are large, one small. The anterior large claw is modified at the distal end by having a flattened raised surface which contacts the anterior edge of the posterior claw. The smallest claw is on the inside of the appendage. The base of the penis (Fig. 13) is very much elongated without any division at the distal end. The longest and most heavily chitinized of the appendages (Fig. 13-A) is peculiarly divided near the distal end. The long slender appendage (Fig. 13-B) lies against the heavy appendage distally and extends slightly more posteriorly. It has a small terminal spine. The third and most dorsal of the appendages (Fig. 13-C) has a short base and apparently a single straight distal seta.

Remarks: E. copiosa sp. nov. differs from some species of the subgenus Cytherites by having only six podomeres in the antennules. It differs from

E. insignipes by having all of the podomeres of the maxillary palp fused together and from *E. donnaldsonensis* by having three rather than two claws at the distal end of the antenna in the male. *E. copiosa* sp. nov. differs from *E. columbia* by the more evenly rounded shell and the fusion of the podomeres of the mandibular palp in the former. The penis also furnishes important specific characteristics.

Ecology: This species is apparently the most common of Entocythere species in east central Illinois. It occurs in great numbers and has been taken from the following species of crayfish:

Cambarus immunis Hagen	7 collections
Cambarus virilis Hagen	2 collections
Cambarus propinquus Girard	2 collections
Cambarus blandingii acutus Girard	2 collections

E. copiosa sp. nov. was also found in water taken from crayfish burrows.

Distribution: E. copiosa is known from the following counties in Illinois: Vermilion, Champaign, Lawrence, Crawford, Piatt, Henry, and Hardin. With the exception of Henry County, these are in the east central, southeastern, and southern parts of Illinois.

The holotype (female) and allotype (male) of this species will be deposited in the U. S. National Museum. The paratypes will be placed in the collections of H. J. Van Cleave, Arthur G. Humes, and the writer.

Summary

1. The European cytherid genus Sphaeromicola Paris 1916 and the American genus Entocythere Marshall 1903 are grouped into the new subfamily Entocytherinae.

2. The genus Cytherites Sars 1926 is declared a synonym of the genus Entocythere Marshall 1903 but is retained as a subgenus.

3. A review of the subfamily Entocytherinae is given.

4. The feeding habits, degree of parasitism, and host specificity of American Entocytherinae are discussed briefly.

5. Two new species, *E. illinoisensis* of the subgenus Entocythere and *E. copiosa* of the subgenus Cytherites, are described from Illinois crayfishes.

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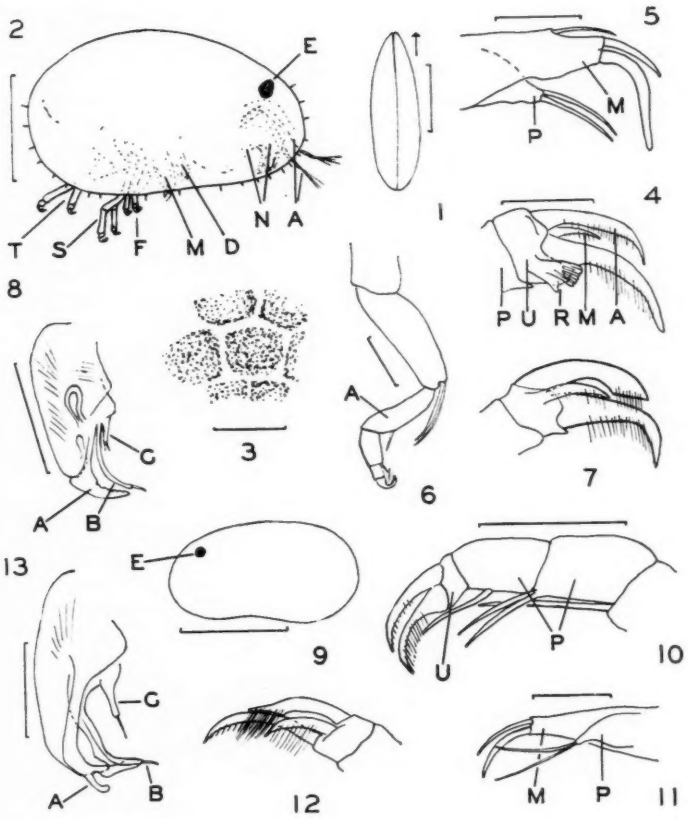
QUINCY COLLGE,
QUINCY, ILL.

EXPLANATION OF FIGURES

(Unless otherwise stated, all drawings are made from material mounted in diaphane. A camera lucida was used.)

Figs. 1-8. *Entocythere illinoisensis* sp. nov. 1. Dorsal view of shell of female (in alcohol). Arrow indicates the anterior end. Scale: 0.25 mm.—2. Lateral view of female (in alcohol). Scale: 0.25 mm. A—antennules, D—mandible, E—eye, F—first thoracic legs, M—maxillae, N—antennae, S—second thoracic legs, T—third thoracic legs.—3. Surface sculpturing of the shell. Scale: 0.02 mm.—4. Outside view of the distal end of the antenna (female). Scale: 0.025 mm. A—anterior distal claw, M—middle distal claw, P—penultimate podomere, R—spur and scale-like appendage, U—ultimate podomere.—5. Maxillary process and end of maxillary palp. Scale: 0.025 mm. M—palp, P—masticatory process.—6. Outside view of the right first leg of female. Scale: 0.05 mm. A—antepenultimate or second podomere.—7. Inside view of the terminal end of the left antenna of the male. Scale as in Fig. 4.—8. Penis. Scale: 0.1 mm. A—clasping appendage, B—tactile organ or end of vas deferens (?), C—possible end of furca.

Figs. 9-13. *Entocythere copiosa* sp. nov. 9. Outside view of the female shell. Scale: 0.25 mm.—10. Distal end of the antenna of the female. Scale: 0.04 mm. P—penultimate podomere, U—ultimate podomere.—11. Inside view of the maxillary process and the distal end of the palp. Scale: 0.025 mm. M—palp, P—masticatory process.—12. Distal podomere and claws of the antenna of the male. Scale as in Fig. 10.—13. Penis. Letters as in Fig. 8. Scale: 0.05 mm.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Land and Fresh Water Mollusca of New Hampshire

Frank C. Baker

A glance at the literature covering the occurence of the Mollusca in the state of New Hampshire shows that this fauna is less known than that of any other state in New England. In Johnson's List of Mollusca (1915) the absence of records from this state is noteworthy. A search of the literature shows that but seven papers have been published on the molluscan fauna of New Hampshire. These are listed at the end of this paper. One of these deals with the region near Keene, one in the Mt. Monadnock area and two on the territory about Intervale and North Conway. Two papers by Clench and Russell cover the Merrimack and Connecticut drainages.

A careful survey of the state over a period of years would probably yield a molluscan fauna equal to that of Maine, which, in fact, the fauna of New Hampshire greatly resembles. Land snails are abundant in certain localities and absent from other territory which is unsuited to their development. Eighteen species are listed from near North Conway by Temple Prime. Twelve species are noted by W. H. Dall from the Mt. Monadnock area.

Fresh water species are plentiful in some bodies of water and are absent from others. Walker and Coolidge list 19 species from near Keene. Clench and Russell, in their two reports in the Biological Survey of the Merrimack and Connecticut water sheds (1938, 1939) list 47 species of fresh water shells as occurring in the state and 30 species which are likely to be found, a total of 77 species and races. Specific localities are given in these papers and a good start has been made for a thorough understanding of the distribution and contents of the fluviatile and lacustrine mollusk fauna of the state.

A part of the summer of the years 1939, 1940, and 1941 was spent in New Hampshire and with the lack of sufficient specific information on the New Hampshire fauna in mind, collections were made in several places in the state, including the Winnipesaukee Lake region, the Lake Sunapee area, Newfound Lake, the upper Connecticut River and several places widely separated from these areas. Twenty-one species of fresh water mollusks were collected including four species not listed by Clench and Russell.

Fresh Water Mollusca

Elliptio complanatus (Dillwyn).—Merrimack Drainage: Carroll Co., Lake Wentworth; Mirror Lake; Lake Kanasatka (Long Lake); Belknap Co., Halfmoon Lake; Grafton Co., Newfound Lake; Saco Drainage: Carroll Co., Chocorua Lake; Connecticut Drainage: Sullivan Co., Lake Sunapee.

This species is the most abundant and widely distributed mussel in New Hampshire. In the lakes examined it was found buried in a sandy or clay

bottom in water two to five feet deep. In this state, as elsewhere, it seems to be the favorite food of the muskrat.

Alasmidonta undulata Say.—Merrimack Drainage: Carrol Co., Lake Wentworth, the only place in which this species was found. Its usual habitat was in 3-4 feet of water buried in a fine, hard sand bottom. The shells are small, the largest specimen measuring 42 mm. in length. The surface is bright and shining and is distinctly rayed with greenish. The nacre is silvery with a suffusion of rose color near the anterior and posterior ends.

Anodonta cataracta Say.—Merrimack Drainage: Belknap Co., Halfmoon Lake; Connecticut Drainage: Sullivan Co., Sunapee Lake, west shore. Halfmoon Lake is a shallow lake or pond with mud bottom and is choked with vegetation. The mussels were found near the middle of the pond on a small island surrounded by six feet of water, where presumably the clams lived as they could not be found in shallow water. The shells are large, attaining a length of 113 mm.

In Sunapee Lake the clams were found in Burkehaven Bay on a sand and clay bottom in water from 3 to 5 feet deep. These specimens were much smaller than those from Halfmoon Lake, the largest measuring 91 mm. in length.

Anodonta implicata Say.—Merrimack Drainage: Carroll Co., Wentworth Lake; Mirror Lake; Lake Kanasatka (Long Lake). This species was observed living on a firm sand bottom in water from 3 to 6 feet in depth. The largest specimen observed measured 85 mm. in length. One specimen 70 mm. long showed repair work from an injury when it was 35 mm. long. A break in the left valve 25 mm. long had been repaired by the formation of a long blister on the inside of the shell. Both valves had been affected. The nacre was salmon colored and the left valve contained many small, pin-head pearls.

These two Anodontas, *implicata* and *cataracta*, are very variable and are often difficult to separate. Typically, the beaks or umbonal markings of *implicata* begin as a faint double loop but soon become straight and run parallel with the hinge line. In *cataracta*, the umbonal markings are strongly double-looped, as in *Anodonta grandis*, to which *cataracta* is related. Also, *implicata* is more polished, has distinct rays, and the shell is often a vivid green near the posterior end. In *cataracta* the epidermis is rough and the color of the shell is more uniformly greenish-brown. Both Ortmann and Simpson call attention to the difference in umbonal markings of the two species.

Clench and Russell (1939, p. 224) state that *implicata* is unrecorded from New Hampshire and list all of this form of Anodonta under *cataracta*. The specimens from Lake Wentworth are like the figure 5, plate iv, of the 1939 report of Clench and Russell, and the specimens here listed as *cataracta* are like figure 3, plate A of the 1938 report. The shells from Lake Wentworth, and elsewhere, have the umbonal markings of *implicata* and should, apparently, be included in this species, which is, therefore, found in New Hampshire.

SPHAERIIDAE

Musculium partumeium (Say). — Merrimack Drainage: Carroll Co., swampy border of brook near Lake Wentworth. On mud bottom in four feet of water.

Musculium truncatum (Linsley).—Merrimack Drainage: Carroll Co. In above locality.

Musculium securis (Prime).—Merrimack Drainage: Carroll Co. In above locality.

Musculium securis sphaericum (Anthony).—Merrimack Drainage: Merrimack Co., pond at side of route 11, near Wilmot Flat. On a mud bottom in 3 feet of water. This race is larger than *securis* and has a rounded, not angular, outline of the shell.

Pisidium spp.—Merrimack Drainage: Belknap Co., Halfmoon Lake; Carroll Co., Harvey Brook. Connecticut Drainage: Sullivan Co., Burkehaven Bay, Lake Sunapee and small brook near Burkehaven Bay. Probably at least three species are represented in the collections. The genus was not plentiful anywhere and was found in only a few localities. Owing to the confusion in the genus concerning just what species are represented, no attempt has been made to identify the species. Since the death of Dr. V. Sterki no one has come forward to take his place in the study of these difficult little clams.

VIVIPARIDAE

Campeloma decisum (Say).—Merrimack Drainage: Carroll Co., Lake Wentworth; Mirror Lake; Lake Kanasatka (Long Lake); Grafton Co., Fowler River; Belknap Co., Halfmoon Lake. Connecticut Drainage: Sullivan Co., Burkehaven Bay, Lake Sunapee. In Lake Wentworth this species was found on a sand bottom near shore in water from 6 inches to 2 feet in depth. At Halfmoon Lake it was found on a mud bottom in two feet of water. In Burkehaven Bay it was found on a clay bottom in water 1 to 2 feet deep.

All of the specimens of *decisum* had a truncated spire with the apex plugged with shelly matter. Adult shells measured 24-27 mm. in length and had 2½ whorls. In immature specimens 7 mm. in length the spire was truncated as in adult shells. No embryonic shells were contained in any of the New Hampshire specimens. Binney (L. & F. W. Shells, p. 41) figures the spire of *decisum* as truncated and Say's original figure shows the same thing. Specimens from Maine, Vermont and Canada are also truncated. Clench and Russell (1938) figure a rather obese specimen without spire truncation (plate B, fig. 10). The question arises, is this truncation a specific character and is there more than one species of Campeloma in New Hampshire (cf. *integrum*)?

AMNICOLIDAE

(*Hydrobiidae* of Clench and Russell)

Amnicola limosa Say.—Merrimack Drainage: Grafton Co., Fowler River. On a mud bottom among submerged vegetation, in shallow water. These

specimens have the narrow umbilicus and blunt spire described by Pilsbry as typical.

Amnicola limosa porata Say.—Connecticut Drainage: Sullivan Co., Burkehaven Bay, Lake Sunapee. Found in water 4-5 feet deep on a narrow-leaved Potamogeton, which grew on a clay bottom. This is the form with widely open umbilicus and pointed spire which is so abundant in the lakes of New York state. They are like examples of *porata* from Lake Cayuga, the type locality.

Clench and Russell (1938) evidently include the *porata* form under *limosa*, since this is the form figured on plate B (fig. 12), and do not differentiate the creek form from the lake form. Most of their records probably belong under *porata* rather than *limosa*.

PHYSIDAE

Physa heterostropha Say.—Merrimack Drainage: Carroll Co., Harvey Brook near Lake Wentworth, swampy mouth of brook on west side of Lake Wentworth; Grafton Co., Baker Creek. Connecticut Drainage: Sullivan Co., small brook flowing into Fischer's Bay, Lake Sunapee; Coos Co., Connecticut River near entrance of Indian Stream.

With one exception, the swampy mouth of a brook near Lake Wentworth, all habitats of this species which have been personally examined have been in brooks or small rivers with clear, running water. In the Connecticut River locality, which was about 50 feet wide, the Physas were found near shore in the quieter water, in small pools among the rocks. None were found in the swift water of the middle of the river. In small brooks, as Harvey Brook, the snails were on a sand bottom in running water.

The New Hampshire specimens differ from the examples from the type locality near Philadelphia in being darker in color and in having the spiral striae more distinct, giving the surface a silky sheen instead of the smooth and polished appearance of specimens from the type locality. The species has been described as smooth and without distinct spiral lines, but these are present in specimens from Philadelphia.

Physa ancillaria Say.—Merrimack Drainage: Merrimack Co., small pond near Wilmot Flat, beside route 11. Connecticut Drainage: Sullivan Co., small brook near Burkehaven Bay, Lake Sunapee. Both habitats are in quiet, shallow water on mud bottom.

LYMNAEIDAE

This family appears to be rare in New England, judging by the records and by collecting experience. The absence of the little Fossaria, of which four or five species and races should be found, is noteworthy. None of the larger species were observed.

Pseudosuccinea columnella (Say).—Merrimack Drainage: Carroll Co., behind barrier beach, Wentworth Lake, near Wentworth Park; Belknap Co., Halfmoon Lake; Grafton Co., Fowler River. The specimens are all immature

and with one exception all habitats were on the leaves of Nymphaea. The habitats, also, were in quiet water near the shore of a river or lake, or in a swampy area of a brook.

PLANORBIDAE

Gyraulus hirsutus (Gould).—Merrimack Drainage: Belknap Co., Halfmoon Lake. On submerged vegetation in a shallow pond choked with vegetation. It is apparently rare.

Helisoma anceps (Menke). Synonyms: *Planorbis anceps* Menke, 1830. *Planorbis antrosus* Conrad, 1834. *Planorbis bicarinatus* Say, 1817 (not of Lamarck, 1804).—Merrimack Drainage: Carroll Co., beach barrier pool, near Wentworth Park, Lake Wentworth; Isolated pond, Lake Wentworth; Belknap Co., Halfmoon Lake. Grafton Co., Fowler River. Habitats mostly in quiet water near shore. Apparently a common species in New Hampshire.

Helisoma anceps portagense (F. C. Baker). — Connecticut Drainage: Sullivan Co., Burkehaven Bay, Lake Sunapee. Two empty shells of a *Helisoma anceps* were found on the shore of this Bay after a storm. They approach nearest to the race known as *portagense* described from Aroostook Co., Maine. The left side lacks the decided keel about the depressed spire which is so characteristic of this race and the carina around the right side of the whorls is not as sharply defined and is not placed at the extreme edge of the body whorl, in this respect resembling the race known as *latchfordi* (Pilsbry) from Meach Lake, Quebec. In fact, the Burkehaven specimens, in some respects, resemble *latchfordi* more closely than they do *portagense*, and additional material from this lake is highly desirable.

Diligent search was made for the natural habitat of this Helisoma but it was not found during a period of five weeks, the length of time spent in this locality.

Helisoma anceps aroostookense (Pilsbry).—Connecticut Drainage: Coos Co., Connecticut River near entrance of Indian Stream. Mostly immature specimens collected. This race of *anceps* was abundant in shallow water in pools among the rocks near shore. They were not observed in the swift current toward the middle of the river. They were associated with *Physa heterostropha*.

Young and immature specimens are like the same stages of typical *anceps*, the characteristics of *aroostookense*, the reduction of the carinae and the narrowing of the umbilical-like spire, taking place when the snail approaches maturity. The race is reported from Profile Lake, Franconia Notch, by Clench and Russell. The variety was first noted in Barren Brook, Aroostook Co., Maine.

Helisoma campanulatum (Say).—Connecticut Drainage: Sullivan Co., Burkehaven Bay, Lake Sunapee. Two empty shells of the typical form of *campanulatum* were found on the beach at Burkehaven Bay after a storm. Living specimens were not found and they may live in the same habitat as *Helisoma anceps portagense*.

Helisoma campanulatum davisi Winslow.—Merrimack Drainage: Carroll Co., beach barrier pool, west side Lake Wentworth; swampy mouth of brook near Lake Wentworth; Mirror Lake. Belknap Co., Halfmoon Lake.

This race is usually found in shallow water among submerged vegetation. It was very abundant among floating vegetation in Halfmoon Lake and in submerged vegetation in pools near Lake Wentworth. All specimens studied from the Merrimack Drainage appear to be referable to this race of *campanulatum* in which there are three whorls visible on the umbilical side, the whorls increasing regularly in diameter, lacking the sudden enlargement of the penultimate whorl as seen in typical *campanulatum*. The aperture is also less campanulate than in the typical form. The *Helisoma campanulatum ferrissi* listed by Clench and Russell (1939, p. 227) may belong to this race. *Ferrissi* was described from fossil specimens and its status is not quite clear. The *davisi* race has been observed in many places in the United States and Canada.

Planorbula jenksii (H. F. Carpenter).—Merrimack Drainage: Carroll Co., swampy mouth of brook near Lake Wentworth; Belknap Co., Halfmoon Lake. Found in quiet water among submerged vegetation. Not common.

Planorbis jenksii was first recorded from Rhode Island in 1887. It has recently been demonstrated by Pilsbry that *jenksii* is a Planorbula which is peculiar to the eastern states but related to *armigera* of the central states. The references to *Planorbula armigera* in Clench and Russell, 1938 and 1939, should be to *Planorbula jenksii*.

ANCYLIDAE

One species of this family, *Ferrissia tarda* (Say), is recorded from New Hampshire by Clench and Russell (1938). Although search was carried on for these tiny, limpet-like snails in their recorded habitats, none were found during the collection periods of the three summers. Lily pads, stones and the inner valves of empty mussel shells are favorite haunts for these mollusks. The family is common in Maine and Massachussetts and it should occur with equal abundance in New Hampshire.

Land Mollusca

The land snails of New Hampsihre have received little attention. Four articles have been written which list the land snails of certain regions in the state. Temple Prime (1870) lists 18 species from the region of North Conway. Dall (1916) lists 12 species from the Mt. Monadnock region. In Johnson's List of Mollusca in the Fauna of New England (1915) 21 species are definitely recorded as living in New Hampshire. The writer collected 25 species and races of which 9 have not been previously reported from the state. Since no complete list of the land mollusks of New Hampshire has been published it has seemed of value to include those already reported in the published list of papers, therefore, in the following catalog those species or races personally collected are marked with an *, those from other sources are followed by the name of the author in parenthesis.

One feature of habitat relationship of the land shells has been the influence of coniferous versus deciduous woodlands on the presence of pulmoniferous mollusks. It has been positively stated by competent authority that land species usually shun a region in which pine, spruce or other coniferous trees predominate and are practically absent from pure stands of these forests. To test this statement in New Hampshire the forest covering of all habitats were noted with the result that it was definitely shown that land snails were not usually found in forests consisting chiefly of coniferous trees but were common in a mixed forest of coniferous and deciduous trees. In most localities no snails were found in or under fallen logs of pine, spruce or other coniferous trees but were common on oak, maple, birch or other deciduous trees. Even when logs of the two types were lying side by side the mollusks chose the deciduous tree and shunned the coniferous tree.

In two localities, however, snails were found in a pure coniferous habitat and under the started bark of large pine trees. This feature was noted in the woods on the south and west shores of Newfound Lake. It is to be noted, however, that the trunks and twigs of the coniferous trees had been lying on the ground for a long time, several years, and were quite dry as far as the wood was concerned, that is, there was no sap or resin. No snails were found on fresh branches or logs of coniferous trees and the reason may be that the objectionable sap was present.

The soil in New Hampshire is largely acid because of the lack of limestone rocks, these usually being of crystalline nature, granites, gneisses and mica schists, usually considered unsuited for molluscan development. The mollusks, however, have well formed shells, fairly thick, and the species occur abundantly in both number of species and individuals in certain habitats. Thus within a radius of ten feet from the base of an old tree near Lake Sunapee thirteen species of land snails were found. In most places one could find from four or five to eight or ten species in a small area. The metamorphic rocks of the state do not seem to be a detriment to the development of a large and widespread molluscan fauna*

POLYGYRIDAE

**Triodopsis tridentata* (Say).—Sullivan Co., woods west side Lake Sunapee. Merrimack Co., Concord; Squam Lake (Johnson). Apparently rare.

**Triodopsis albolabris* (Say).—Carroll Co., woods west side of Lake Wentworth; woods bordering Passaconaway highway near town of Passaconaway, in valley of Swift River; Sullivan Co., woods west side of Sunapee Lake near Burkehaven. Maine to Connecticut (Johnson). Carroll Co., Intervale (Rehder), North Conway (Prime). Cheshire Co., Mt. Monadnock (Dall).

The records indicate that *albolabris* is widely distributed in the state.

* See Van der Schalie, Larger Land Shells from Pine Woods in Northern Michigan, Mich. Acad. Sci. Arts, Lett., **25**:367-370, 1940.

Immature specimens were common during August. The adult specimens, while of good size, were rather thin, in strong contrast with the heavy, thick shells of this species as found in the limestone regions of Illinois.

Mesodon dentiferus (Binney).—Cheshire Co., Fitzwilliam (Johnson).

Mesodon thyroidus (Say).—Cheshire Co., Mt. Monadnock (Dall). The last two species have been reported only from the southern portion of the state.

Stenotrema fraterna (Say) *Polygyra monodon* of authors, not Rackett.—Carroll Co., Lovermore and Jackson; Coos Co., Glen House (Johnson). Carroll Co., Intervale (Rehder). Carroll Co., North Conway (Prime). Cheshire Co., Keene (Walker & Coolidge). Cheshire Co., Mt. Monadnock (Dall first listed as *palliata*, later changed to *monodon*).

**Stenotrema fraterna cava* Pilsbry and Vanatta.—Carroll Co., woods west side Lake Wentworth. Coos Co., Stratford Hollow; woods near Third Connecticut Lake. Sullivan Co., woods bordering west shore Sunapee Lake, near Burkehaven.

All specimens of *fraterna* personally collected have been referable to the more recently described race *cava*. Possibly all or most of the records under *fraterna* should be placed under *cava*, which has a more or less widely open umbilicus. The small, widely umbilicated species known as *monodon* Rackett does not occur in New Hampshire.

ZONITIDAE

**Zonitoides arboreus* (Say).—Carroll Co., woods on west shore of Lake Wentworth; Passaconaway Road near Passaconaway, in valley of Swift River. Coos Co., Stratford Hollow; Woods near third Connecticut Lake. Grafton Co., Melton Falls Park near Alexandria; woods south and west side Newfound Lake. Sullivan Co., woods near Burkehaven, west side Sunapee Lake. Maine to Connecticut (Johnson). Carroll Co., North Conway (Prime); Intervale (Rehder). Cheshire Co., Keene (Walker & Coolidge); Mt. Monadnock (Dall).

This species is probably distributed throughout New Hampshire. It was always abundant wherever found by the writer and occurred in many ecological situations, even under the started bark of old pine logs.

Retinella electrina (Gould) = *Vitrea hammonis* (Ström).—Carroll Co., Intervale (Rehder); North Conway (Prime). Cheshire Co., Mt. Monadnock (Dall). Maine to Connecticut (Johnson).

**Retinella binneyana* (Morse).—Carroll Co., woods west side of Lake Wentworth. Coos Co., Stratford Hollow. Sullivan Co., near Burkehaven, Lake Sunapee. Belknap Co., Threemile Island, near Meredith Neck, Lake Winnepesaukee (Johnson).

Binneyana and *electrina* are closely related species, the former having a

more hyaline shell. Specimens personally collected appeared referable to *binneyana* and some of the records under *electrina (hammonis)* may belong under *binneyana*.

**Retinella indentata* (Say).—Carroll Co., woods west side Lake Wentworth. Carroll Co., Intervale and North Conway (Rehder and Prime).

**Retinella wheatleyi* (Bland).—Sullivan Co., near Burkehaven, Sunapee Lake. Rare. Agrees well with specimens from Illinois. Listed by Johnson only from Rhode Island. It occurred on the ground under debris of leaves and sticks.

**Retinella rhoadesi* Pilsbry. — Sullivan Co., near Burkehaven, Sunapee Lake. Rare, associated with *Zonitoides arboreus* under debris on the ground. It is distinctly umbilicated with the impressed radiating lines as well impressed and as widely spaced as in *Retinella indentata*. Listed by Johnson from Maine and Connecticut.

**Striatura exigua* (Stimpson). — Sullivan Co., near Burkehaven, Lake Sunapee. Carroll Co. North Conway (Prime). Nine specimens of this tiny land snail were found among debris on the ground on a hillside. The rib sculpture is variable, in some specimens being almost obsolete, but the growth sculpture is coarse in all specimens.

**Striatura milium* Morse.—Sullivan Co., near Burkehaven, Lake Sunapee. Not common. Found under woody debris on the ground.

Hawaiia minuscula (Binney). — Carroll Co., North Conway (Prime). Apparently rare. Not recorded by Johnson.

**Euconulus fulvus* (Müller). — Sullivan Co., near Burkehaven, Lake Sunapee. Grafton Co., woods on south and west side of Newfound Lake. Coos Co., Stratford Hollow. Carroll Co., North Conway (Prime).

Not common and usually found on the ground under woody debris. One specimen was collected on a pine twig.

**Euconulus chersinus polygyratus* Pilsbry. — Sullivan Co., near Burkehaven, Sunapee Lake. A single specimen of this form of *chersinus*, with the depressed spire, was found under a piece of wood on the ground.

LIMACIDAE

Deroceras agreste (Linn.).—Cheshire Co., Mt. Monadnock (Dall).

**Deroceras gracile* Rafinesque (=*Agriolomax campestris* Binney). — Carroll Co., woods west side Lake Wentworth. Carroll Co., North Conway (Prime). This small slug was found commonly under sticks and debris on the ground.

PHILOMYCIDAE

**Philomycus carolinianus* (Bosc).—Carroll Co., woods west side Wentworth Lake; Passaconaway Road near Passaconaway, in valley of Swift River. Grafton Co., south and west side Newfound Lake. Carroll Co., North Conway (Prime).

This large slug appears to be widely distributed over the state. It is notably gregarious in its habits, a number of individuals usually being found in one

location. Near Lake Wentworth it was found under logs of deciduous trees and in one place a dozen specimens were found under the bark of a standing birch trunk, part of a burn over, at a height of from four to six feet above the ground. The individuals ranged from an inch to three inches in length. At Passaconaway, large individuals were found in and under birch trees. At Newfound Lake this species occurred abundantly under the started bark of prostrate old pine trees, as many as ten specimens of various ages being observed together.

Philomycus pennsylvanicus Pilsbry.—Cheshire Co., Mt. Monadnock (Dall, Johnson).

In 1894 Pilsbry described from Maryland and Pennsylvania a Philomycus which was smaller and less distinctly marked than *cerolinianus* and having a strongly ribbed jaw. Since Dall's record in 1916 no other example of this species has been recorded from New Hampshire. All specimens personally collected have been obviously of the large, dark-mottled *carolinianus*. It was noted that there was considerable variation in color markings among the specimens of the larger species, light and less clouded individuals occurring with dark, heavily blotched specimens. It is possible that Dall's specimens were a light phase of *carolinianus*. There is no evidence that the form was dissected to ascertain the nature of the jaw.

**Pallifera dorsalis* (Binney).—Carroll Co., woods west end Lake Wentworth; Passaconaway Road, near Passaconaway, in valley of Swift River. Grafton Co., woods south and west side Newfound Lake.

Pallifera was common, associated with Philomycus. Color variation is marked in this species and one is led to wonder whether there may not be more than one species in New Hampshire. Individuals almost colorless were found in some places while in others there was considerable color on the back and sides. A study of both Philomycus and Pallifera in this state would probably be of considerable interest.

ENDODONTIDAE

**Pyramidula alternata* (Say).—Coos Co., woods near Third Connecticut Lake. Maine to Connecticut (Johnson). Carroll Co. North Conway (Prime); Intervale (Rehder). Cheshire Co., Mt. Monadnock (Dall).

Pyramidula alternata, while widely distributed, does not appear to occur abundantly at any one locality.

Discus cronkhitei anthonyi (Pilsbry).—Maine to Connecticut (Johnson). Carroll Co., North Conway (Prime); Intervale (Rehder). Cheshire Co., Keene (Walker & Coolidge).

**Discus cronkhitei catskillensis* (Pilsbry).—Carroll Co., west side Lake Wentworth; Passaconaway Road near Passaconaway, in valley of Swift River. Coos Co., Stratford Hollow. Sullivan Co., near Burkehaven, Sunapee Lake. Cheshire Co., Mt. Monadnock (Dall).

Two races of *cronkhitei* have been reported from New Hampshire. Only the one known as *catskillensis* has been personally collected. It seems likely

that *anthonyi* occurs in the southern part of the state and *catskillensis* in the northern part and in the mountains. The latter race has a decidedly keeled periphery.

**Helicodiscus parallelus* (Say). — Carroll Co., woods west side Lake Wentworth. Coos Co., Stratford Hollow. Grafton Co., west side Newfound Lake. Sullivan Co., near Burkehaven, Sunapee Lake. Carroll Co., North Conway (Prime).

Apparently common, usually associated with Discus.

**Planogyra asteriscus* Morse.—Carroll Co., west side Lake Wentworth. Apparently rare. The few specimens found are quite typical with membranous ribs and wide umbilical region. They occurred in ground debris.

PUPILLIDAE

**Gastrocopta pentodon gracilis* Sterki.—Grafton Co., near Burkehaven, Sunapee Lake. One specimen of this small species was found under started bark. From the lack of records it would appear that Gastrocopta is rare in New Hampshire.

**Vertigo ovata* Say. — Grafton Co., near Burkehaven, Lake Sunapee. Rockingham Co., Portsmouth (Johnson). Apparently not common.

Vertigo bollesiana (Morse).—Hillsboro Co., Francestown (Johnson).

Vertigo ventricosa (Morse).—Merrimack Co., Concord (Johnson, Morse).

Pupilla muscorum (Linn.).—Carroll Co., North Conway (Prime).

Columnella edentula (Drap.).—Hillsboro Co., Francestown (Johnson).

Zoogenites harpa (Say).—Coos Co., Berlin Falls; Carroll Co., Wolfboro (Johnson).

The little pupoid snails appear rare or they are difficult to find. The fact that so few were found after three summers of intense collecting would indicate that they were both rare and difficult to find.

STROBILOPSIDAE

**Strobilops labyrinthica* (Say).—Sullivan Co., near Burkehaven, Lake Sunapee. Coos Co., Stratford Hollow. Belknap Co., Threemile Island, near Meredith neck, Lake Winnepesaukee (Johnson). Carroll Co., North Conway (Prime).

Strobilops was common under started bark and among chips from lumbering operations. It was always found on deciduous logs and chips, never on pine.

**Strobilops labyrinthica parietalis* Pilsbry.—Carroll Co., west side Lake Wentworth. Under started bark. All specimens examined from this habitat had the two parietal lamellae extending into the whorl about three-fourths of a turn, differing from the typical form which has the parietal lamellae entering only about one-half of a turn.

**Strobilops labyrinthica virgo* (Pilsbry).—Carroll Co., Passaconaway Road near Passaconaway, valley of Swift River; west side Lake Wentworth. Cheshire Co., Mt. Monadnock (Dall).

Not common. *Virgo* is evidently a color variety of *labyrinthica*.

COCHLICOPIDAE

Cochlicopa lubrica (Müller).—Maine to Connecticut (Johnson). Carroll Co., North Conway (Prime).

**Cochlicopa lubrica morseana* Doherty. — Carroll Co., west side Lake Wentworth. Sullivan Co., near Burkehaven, Lake Sunapee.

Specimens of *Cochlicopa lubrica* personally collected have been referable to the race *morseana*. Probably both the typical form and the race live in the state but they have not previously been differentiated.

VALLONIIDAE

It is noteworthy that no specimens of Vallonia have thus far been reported from New Hampshire. None were seen during the three summers of collecting and none are listed by Johnson, Dall, Rehder, or Prime. Prime, in fact, states that he could not find *pulchella*. As the genus is recorded from Maine and Massachusetts it should also be found in New Hampshire.

SUCCINEIDAE

**Succinea ovalis* Say (=*totteniana* Lea).—Carroll Co., west side Lake Wentworth; Passaconaway Road near Passaconaway, valley of Swift River. Sullivan Co., near Burkehaven, Lake Sunapee. Merrimack Co., Mt. Kearsage, at tourists camp. Coos Co., Stratford Hollow. Maine to Connecticut; Hillsboro Co., Francestown (Johnson). Carroll Co., near North Conway (Prime). Cheshire Co., Mt. Monadnock (Dall).

Succinea ovalis is common but not abundant. It was usually found under debris and adhering to sticks and the under side of logs.

Succinea retusa Lea.—Maine to Connecticut (Johnson). No specimens of this species were found by the writer.

My thanks are due Dr. William J. Clench for the identification of some of the Physae and for assistance in making up the bibliography.

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Check List and Bibliography of North American Earthworms

G. E. Gates

Descriptions and records of distribution of more than two hundred species of North American earthworms are scattered through one hundred-odd articles published in five languages in journals of eight countries through a period of 121 years. No check list or bibliography has been available hitherto.

Many of the species are inadequately characterized and the percentage of valid species cannot be estimated at present with any degree of probability. Those that prove to be good species will be but a fraction of the number remaining to be discovered in the area under consideration.

As North America is continuous with South America, a line of demarcation must be drawn somewhere and for the purposes of this list the line is placed at the Panama Canal. The West Indies are included but Aruba, Curacao, Bonaire, Trinidad and Tobago are omitted. This enables omission from the list of primarily South American genera which reach into Trinidad (*Rhinodrilus* E. Perrier 1872) or Darien (*Thamnodrilus* Beddard 1887, *Periscolex* Cognetti 1905, and *Andioscolex* Michaelsen 1927) but species or records from Darien of primarily North American genera have been included. Quite possibly some of the South American forms now known only from Darien will be found this side of the canal. Among those most likely to be obtained are: *Thamnodrilus darienianus* Cognetti 1905, *Periscolex brachycystis* (Cognetti) 1905, *P. mirus* Cognetti 1905, *Andioscolex crassicauda, nemoralis, parsus,* and *smithi* (Cognetti) 1905.

The classification used herein is that of Stephenson (1930), except as concerns the Moniligastridae and Megascolecidae (for which *vide* Gates, 1939, Thai Earthworms, *J. Thailand Research Soc. Nat. Hist. Sup.* 12(1): 71-72) and with replacement of *Acanthodrilus* by *Eodrilus, Kerria* by *Eukerria* as well as addition of *Balanteodrilus*. Serial order of families and genera is that of Stephenson (1930), the species arranged alphabetically. Family and generic definitions, many of which are in need of revision, may be found in Stephenson's monograph (1930).

More than forty years ago Eisen (1900, p. 249) called attention to the "disappearance of native species," supplanted by imported European forms (also noted by Spencer in Australia). Smith (1928) has given an account of changes observed in the earthworm fauna of Illinois. If the threat of extinction of native species is as serious as has been thought, a really thorough investigation of our earthworm fauna should be regarded as a matter of considerable urgency.

The author's thanks are extended to Dr. G. E. Pickford for information

that could not be obtained otherwise at the time the manuscript of this list was prepared for press.

KEY TO FAMILIES OF NORTH AMERICAN EARTHWORMS

1. *a.* Testis sacs suspended in intersegmental septa so as to project anteroposteriorly into two successive segments ..... *Moniligastridae.*
   b. Testis sacs lacking or if present not suspended into two segments but restricted to the segments to which the included testes belong 2
2. *a.* Prostates (tubular or racemose) present and opening in common with male deferent ducts or close to male pores or in seminal grooves 3
   b. Prostates lacking ("prostates" not tubular or if tubular not restricted as in *a*) 4
3. *a.* Intestine begins in xii, last hearts in xi ..... *Ocnerodrilidae*
   b. Intestine begins behind xiii, last hearts in xii or xiii ..... *Megascolecidae*
4. *a.* Euprostates (musculoglandular thickenings of ectal portions of male deferent ducts) present ..... *Eudrilidae*
   b. Euprostates lacking 5
5. *a.* Gizzard oesophageal or lacking ..... *Glossoscolecidae*
   b. Gizzard intestinal ..... *Lumbricidae*

Those familiar only with Lumbricid anatomy will find explanations of unfamiliar terms in Stephenson, 1930, Stephenson, 1923 (Oligochaeta, in Fauna of British India, London), or Gates, 1937, pp. 342-346.

Family MONILIGASTRIDAE

Genus DRAWIDA Michaelsen 1900

1. *Drawida bahamensis* (Beddard) 1892.—Known only from the types which were supposedly imported to Kew from the Bahamas. The species is originally Oriental. (*Vide* Beddard 1893.)

Family MEGASCOLECIDAE

KEY TO NORTH AMERICAN GENERA

1. *a.* Male deferent ducts unite with prostatic ducts in coelomic cavity, the junction at or near ental end of prostatic ducts 2
   b. Male deferent ducts do not unite with the prostatic ducts or only within the parietes 5
2. *a.* Excretory system purely meganephridial 3
   b. Excretory system micronephridial 4
3. *a.* Nephridia present anterior to xiii ..... *Plutellus*
   b. Nephridia lacking anterior to xiii ..... *Pontodrilus*
4. *a.* Setae lumbricine, prostates tubular ..... *Megascolides*
   b. Setae perichaetine, prostates racemose ..... *Pheretima*
5. *a.* Two or three gizzards present 6
   b. Only one gizzard present or none 10
6. *a.* Excretory system purely meganephridial 7
   b. Excretory system purely micronephridial or with meganephridia in addition to micro-nephridia 8
7. *a.* Two gizzards ..... *Diplocardia*
   b. Three gizzards ..... *Zapotecia*
8. *a.* Calciferous glands present in region of xiv-xvii 9
   b. No calciferous glands ..... *Trigaster*
9. *a.* Two gizzards ..... *Dichogaster*

b. Three gizzards ..... *Eutrigaster*
10. *a*. Excretory system purely meganephridial 11
b. Excretory system micronephridial, with or without meganephridia..... *Howascolex*
11. *a*. Male terminalia acanthodriline ..... *Eodrilus*
b. Male terminalia not acanthodriline 12
12. *a*. Male terminalia microscolecine ..... *Microscolex*
b. Male terminalia balantine ..... *Balanteodrilus*

Genus EODRILUS Michaelsen 1907

1. *Eodrilus crystallifer* (Eisen) 1900.— Tactic, Guatemala. Known only from the original description of the holotype which probably was sectioned.

2. *Eodrilus divergens* (Cognetti) 1905.—Point Savannah, Darien, Panama. Known only from the types.

3. *Eodrilus hamiger* Michaelsen 1911. — Huehuetenango, Guatemala. Known only from the types.

4. *Eodrilus oxkutzcabensis* Pickford 1938.—Puz cave, Oxkutzcab and San Isidro cave, Merida, Mexico. Known only from the original description.

5. *Eodrilus tamajusi* (Eisen) 1896. — Tamaju, Guatemala. Known only from the types.

6. *Eodrilus tecum-umami* Michaelsen 1911.—Huehuetenango, Guatemala. Known only from the types. (For typhlosole *vide* Hertling, 1923, p. 158).

7. *Eodrilus ulrici* (Michaelsen) 1923. — Rincon, Cuba. Known only from the types.

8. *Eodrilus vasliti* (Eisen) 1896.—Tepic, Mexico. Known only from the types.

9. *Eodrilus whitmani* (Eisen) 1900. — Coban, Guatemala. Known only from the types.

Genus MICROSCOLEX Rosa 1887

Occurrence of two species in North America is due to transportation.

KEY TO NORTH AMERICAN SPECIES

Spermathecae present, male pores separate from the prostatic pores ..... *phosphoreus*
Spermathecae lacking, male pores, prostatic pores and apertures of penisetal follicles in a common atrium ..... *dubius*

1. *Microscolex dubius* (Fletcher) 1887.—San Francisco, Berkeley, Santa Rosa, Santa Barbara, Mt. Diablo, California; Raleigh, North Carolina. Synonymy according to Michaelsen, 1907 (Ergeb. Hamb. sudwestaustralischen Forsch. 1905. Jena.)

2. *Microscolex phosphoreus* (Duges) 1837.—San Francisco, Coulterville, Redding, Santa Barbara, Santa Rosa, Lake Chalot, Alameda county, California; Ensenada de Todos Santos and Sierre Laguna, Baja California; Orizaba, Mexico; Quincy, Florida; Raleigh, North Carolina; Washington, D. C. Synonymy according to Michaelsen, 1907.

Genus BALANTEODRILUS Pickford 1938

1. *Balanteodrilus pearsei Pickford* 1938. — Gongora cave, Oxkutzcab and San Isidro cave, Merida, Mexico. Known only from the original description.

Genus PLUTELLUS E. Perrier 1873

Several species are doubtful. Californian and Guatemalan species have adiverticulate spermathecae, the Californian species quadrithecal, the Guatemalan sexthecal. Oregon and Washington species have diverticulate spermathecae. The Canadian species is octothecal, proandric and with adiverticulate spermathecae.

1. **Plutellus altmani** nom. nov. pro *Plutellus decathecus* Altman 1936 (preoccupied by *Plutellus decatheca* Michaelsen 1910). Willapa Harbor. Washington. Known only from the types.

2. *Plutellus collinus* (Eisen) 1900.— Sonoma, Marin, and Napa counties, California. Known only from the types. A doubtful species. (*Vide* Michaelsen, 1921.)

3. *Plutellus garloughi* Smith 1937.—Multnomah, Oregon. Known only from the types.

4. *Plutellus heteroporus* E. Perrier 1873.—Pennsylvania. This species is the genotype of *Plutellus*. Whether or not types are still in existence is unknown. The type locality is unknown and Pennsylvania origin of the species is very doubtful. The diverticulate spermathecae suggest a Washington or Oregon origin, but the location of the gizzard in vi (possibly mistaken) and the kidney-shaped calciferous glands in x-xii appear to be contraindications. The species is supposedly proandric like the Canadian form but there is some confusion in Perrier's account, — either organs have been misidentified or the segmental locations are erroneous.

5. *Plutellus hyalinus* (Eisen) 1900.—Coban, Guatemala. Known only from the description of a single, macerated specimen.

6. *Plutellus kincaidi* Altman 1936.—Willapa Harbor and Bruceport, Washington. Known only from the original description. Following Combault (1909) Altman states that "the dorsal vessel sends much of its blood through four pairs of oesophageal diverticula." The usual view is that the dorsal trunk is a collecting vessel behind the hearts. The vascular system of this and other species is in need of accurate characterisation particularly with reference to the extra-oesophageal and subneural vessels. This species is set apart from all other Pacific coast forms by the presence of four pairs of external, apparently bilobed calciferous glands as well as by the bifurcation of the typhlosole. All of the Washington species are said to have seminal vesicles in x, xi and xii. This appears to be rather unusual and requires confirmation. Possibly testis sacs in x and xi were mistaken for seminal vesicles.

7. *Plutellus marmoratus* (Eisen) 1893.—Santa Rosa and Sebastopol, north of San Francisco Bay, California. Occurrence in Portland, Oregon, probably mistaken. Distribution and distinction from *papillifer* uncertain.

8. *Plutellus oregonensis* Smith 1937. — Multnomah and Mary's River, Oregon.

9. *Plutellus papillifer* Eisen 1893. — Berkeley, San Francisco, Monterey, Palo Alto, San Joaquin Valley, California (south of San Francisco Bay in Santa Rosa, Santa Clara, Monterey, Fresno and Nevada counties according to Eisen, 1894). Oakland (Michaelsen, 1921). San Mateo and Santa Cruz counties (Gates, in press). Distribution and distinction from *marmoratus* uncertain.

10. *Plutellus perrieri* Benham 1892. — Queen Charlotte Island, Canada. Known only from the original description. This species is the only one that can be regarded as endemic in Canada.

11. *Plutellus sierrae* Michaelsen 1921.—Morphy, Sierra Nevada, California. Known only from the original description of an aclitellate and of two juvenile specimens. A doubtful species, distinguished at present from *papillifer* only by the absence of genital markings.

12. *Plutellus toutellus* Altman 1936.—Toledo, Washington. Known only from the original description of the holotype.

Genus PONTODRILUS E. Perrier 1874

The single American species allowed by Michaelsen (1909) is so variable that Michaelsen felt compelled to recognize several formae all of which are now regarded as of uncertain status. Most of the forms are inadequately characterized and some are known only from immature specimens. The taxonomic status of each of the littoral Pontodrilids requires further consideration after study of sexually mature individuals.

1. *Pontodrilus bermudensis* Beddard 1891. — Bermudas. Hillsborough, Ozona, Florida (Michaelsen, 1894). Haiti (Michaelsen, 1910). Bahamas (Michaelsen, 1921). St. Croix, Virgin Islands (Gates, in press). Jamaica (*hesperidum*, Beddard, 1894). Guymas, Mexico (*michaelseni*, Eisen, 1895). Loreto, Baja California (*michaelseni hortensis*, Eisen, 1895).

2. *Pontodrilus gracilis* Gates (in press).—Fort Myers, Lee county, Florida.

Genus MEGASCOLIDES McCoy 1878

1. *Megascolides americanus* Smith 1897.—Pullman, Washington. Moscow, Idaho. (*Vide* Smith, 1937 and Altman, 1936.)

2. *Megascolides cascadensis* Smith 1937.—Salem, Oregon. Known only from the description of the holotype which was sectioned.

3. *Megascolides eiseni* Smith 1937. — Multnomah, Oregon. Known only from the original description.

4. *Megascolides macelfreshi* Smith 1937.—Salem, Oregon. Known only from the description of the holotype which was sectioned. Possibly not a good species, distinction from *cascadensis* seems doubtful.

5. *Megascolides michaelseni* Smith 1937.—Netarts, Oregon. Known only from the original description.

6. *Megascolides wellsi* Altman 1936.—Monroe, Oregon. Known only from the original description. Distinction from *americanus* requires confirmation. In some genera genital markings may be unreliable as criteria of specific distinctness.

Genus PHERETIMA Kinberg 1867

A key to the North American species, diagnoses and distributions may be found in Gates, 1937, and need not be repeated here. A more recent record (*vide* Howell, 1939) of a Japanese species, *P. agrestis* Goto et Hatai 1899, requires confirmation. A number of Goto and Hatai's species are doubtful. North American distributions are results of importation, directly or indirectly, from eastern Asia or Australasia.

1. *Pheretima bicincta* (E. Perrier) 1875.
2. *Pheretima californica* Kinberg 1867. Louisiana (Gates, in press).
3. *Pheretima diffringens* (Baird) 1869.
4. *Pheretima elongata* (E. Perrier) 1872.
5. *Pheretima hawayana* (Rosa) 1891.—Greenhouses, Hadley, Massachusetts (Gates, in press).
6. *Pheretima hupeiensis* (Michaelsen) 1895.
7. *Pheretima meridiana* Gates 1932.
8. *Pheretima morrisi* (Beddard) 1892.
9. *Pheretima posthuma* (L. Vaillant) 1868.
10. *Pheretima robusta* (E. Perrier) 1872.
11. *Pheretima rodericensis* (Grube) 1897.
12. *Pheretima schmardae* (Horst) 1883.

Genus HOWASCOLEX Michaelsen 1901

1. *Howascolex eiseni* (Michaelsen) 1911.—Huehuetenango, Guatemala. (*Vide* Pickford 1937.)

2. *Howascolex irpex* (Michaelsen) 1911.—Huehuetenango, Guatemala. Finca Manacal bei Tapachula, South Mexico (Michaelesn, 1925). (*Vide* Pickford 1937.)

3. *Howascolex stadelmanni* (Michaelsen) 1935. Lancatilla, Honduras. Known only from two clitellate types. (*Vide* Pickford, 1937.)

Genus DIPLOCARDIA Garman 1888

Diplocardia, supposedly derived from an ancestral acanthodriline by duplication of the gizzard, is difficult to define as most of the organ systems have been blasted, as it were, out of the usual generic uniformity. Thus the intestinal origins may be in any of the segments from xv to xx, calciferous glands may be lacking or of the mesially closed off, internal type or represented by high lamellae without median fusion, a typhlosole may be lacking or present and simple or bifid, the dorsal blood vessel may be single or double and with considerable interspecific variation as to extent of duplicity, hearts may be present or lacking in xiii, the anterior seminal vesicles may be in ix or xi,

prostates may be tubular or of a simple racemose type, spermathecal pores are variable in number and position in a region from 6/7 to 10/11, penial and (or) copulatory setae may be present or lacking, ordinary sigmoid setae may or may not be ornamented and the male pores may be on any segment from xviii to xxi. Only the excretory system seems to have remained uniformly meganephric, appearance of micronephry being regarded as of sufficient importance to warrant recognition of a distinct genus *(Trigaster)*.

Diagnosis.—Acanthodriline relationships of male terminalia retained in spite of variation in segmental location of the external apertures, the prostatic pores located at or close to the termini of seminal grooves, male pores within the grooves. Setae lumbricine. Gizzards in v-vi. Calciferous glands, when present, internal. Hearts of x-xii or xiii latero-oesophageal; extra-oesophageals pass onto ventral face of gut in region of x; no subneural trunk. Excretory system meganephric. Holandric.

KEY TO SPECIES OF DIPLOCARDIA

1. *a.* Anterior prostatic pores on xvii ..... *koebelei*
   b. Anterior prostatic pores behind xvii 2
2. *a.* Male pores on 18/19 or xix 3
   b. Male pores behind xix 16
3. *a.* Last hearts in xii 4
   b. Last hearts in xiii 11
4. *a.* Dorsal blood vessel doubled 5
   b. Dorsal vessel single throughout 7
5. *a.* Quadrithecal 6
   b. Sexthecal ..... *communis*
6. *a.* Calciferous lamellae in xiv with free median margins, posterior spermathecal pores slightly anterior to 9/10 ..... *michaelseni*
   b. Calciferous lamellae in xiv in part united mesially, posterior spermathecal pores on setal arc of ix ..... *floridana*
7. *a.* Quadrithecal 8
   b. Sexthecal 9
8. *a.* Spermathecal pores presetal, genital markings in *bc* ..... *udei*
   b. Spermathecal pores postsetal, genital markings in *aa* ..... *gracilis*
9. *a.* Spermathecal pores intersegmental ..... *singularis*
   b. Spermathecal pores segmental 10
10. *a.* Prostomium epilobous, first dorsal pore on 8/9 ..... *caroliniana*
    b. Prostomium tanylobous, first dorsal pore on (9/10) 10/11 ..... *ornata*
11. *a.* Dorsal blood vessel single 12
    b. Dorsal vessel doubled in part 13
12. *a.* Quadrithecal ..... *riparia*
    b. Sexthecal ..... *longa*
13. *a.* Calciferous glands or high lamellar folds present in xiv-xv 14
    b. No calciferous glands or high lamellar folds in xiv-xv 15
14. *a.* Spermathecal pores presetal, calciferous lamellae united mesially ..... *mississippiensis*
    b. Spermathecal pores postsetal, calciferous lamellae not united mesially ..... *eiseni*
15. *a.* Spermathecal pores on vii-viii, diameter 8 mm. ..... *fusca*
    b. Spermathecal pores on viii-ix, diameter 2 mm. ..... *alba*
16. *a.* Male pores on xx, spermathecal pores on ix and x ..... *verrucosa*
    b. Male pores on xxi, spermathecal pores on viii and ix 17
17. *a.* Male pores presetal, typhlosole present, spermathecal diverticulum at ental end of duct ..... *texensis*
    b. Male pores on setal arc, no typhlosole, spermathecal diverticulum at middle of duct ..... *keyesi*

As Smith failed to record any morphological characteristics distinguishing *fluviatilis* from *singularis*, the former is omitted from the key.

A species from central India, referred by Stephenson to *Diplocardia* but of uncertain relationships, is also excluded.

1. *Diplocardia alba* Gates (in press).—Fort Myers, Lee county, Florida.

2. *Diplocardia caroliniana* Eisen 1899.—Raleigh, North Carolina. Known only from the original description.

3. *Diplocardia communis* Garman 1888.—Central Illinois, three counties of Ohio (Olson, 1928) and thirteen counties of Missouri (Olson, 1936). (Also *vide* Eisen, 1900, Smith, 1895, 1900, 1915, and for calciferous glands Smith, 1924.)

4. *Diplocardia eiseni* (Michaelsen) 1894.—Cedar Hammock, Lake Eola Orlando Arkadia, Sanford, Florida; Savannah, Georgia, Lake Eola, Florida (Smith, 1895). Lake Gatlin, Florida (Ude, 1895). Orange county, Florida (Eisen, 1900). (For typhlosole *vide* Hertling, 1923, p. 189, and for calciferous glands, Smith, 1924.)

5. *Diplocardia floridana* Smith 1924.—Monticello, Florida. Known only from the original description.

6. *Diplocardia fusca* Gates (in press).—Fort Worth, Texas. Known only from the holotype which is aclitellate.

7. *Diplocardia gracilis* Gates (in press). — Tennessee. Type locality unknown.

8. *Diplocardia keyesi* (Eisen) 1896.—Ensenada de Todos Santos, Baja California. Known only from the type. (*Vide* also Eisen, 1899 and 1900.)

9. *Diplocardia koebelei* Eisen 1900.—Morelos, Mexico. Known only from the original description.

10. *Diplocardia longa* Moore 1902. — Pulaski county, Georgia. Known only from the original description.

11. *Diplocardia michaelseni* Eisen 1899. — Raleigh and Durham, North Carolina. (*Vide* also Eisen, 1900, Smith, 1923, Stephenson, 1933, Pickford, 1937, p. 605, and for calciferous glands Smith, 1924.)

12. *Diplocardia mississippiensis* Smith 1924. — McNeill, Mississippi. Known only from the original description.

13. *Diplocardia ornata* Gates (in press). — Tennessee. Type locality unknown.

14. *Diplocardia riparia* Smith 1895. — Illinois. Terre Haute, Indiana (Heimburger, 1915). Ohio (Olson, 1928). Missouri (Olson, 1936). (*Vide* also Eisen, 1899, 1900, and Smith, 1900, 1915.)

15. *Diplocardia singularis* (Ude) 1893.—Illinois (*vide* also Eisen, 1900, Smith, 1895, 1900, 1915, and Ude, 1895.) Indiana (Heimburger, 1915). Ohio (Olson, 1928). Missouri (Olson, 1936). Heimburger notes that Indiana

forms vary from typical forms but gives no details. Variation in worms from different localities should be recorded.

16. *Diplocardia texensis* Smith 1924.—Chillicothe, Texas. Known only from the original description.

17. *Diplocardia udei* Eisen 1899.—Raleigh, North Carolina. Heimburger (1915) records this species from Indiana but this requires confirmation.

18. *Diplocardia verrucosa* Ude 1895.—Omaha, Nebraska. Also recorded from Illinois (Smith, 1915) and Lake St. Mary's, Ohio (Olson, 1933) but these records require confirmation (*vide* in this connection Eisen's remarks in 1900 *re* Smith's specimens).

Genus ZAPOTECIA Eisen 1900

The only distinction from *Diplocardia* according to Stephenson (1930) is the presence of a third gizzard in vii.

1. *Zapotecia amecamecae* Eisen 1900.—Ameca-meca, Mexico. Known only from the original description of the holotype which probably was sectioned.

2. *Zapotecia keiteli* Michaelsen 1902.—Port au Prince, Haiti. Known only from the original description of aclitellate types. The species is distinguished at present from *ameca-mecae* only by the wide separation of the setae posteriorly and the prolobous (rather than epilobous) prostomium.

Genus TRIGASTER Benham 1886

Michaelsen (1900, p. 331) recognized two species, *lankesteri* (with three subspecies *typica, intermedia* and *calwoodi,* all from St. Thomas) and *tolteca.* The account of the typical form of *lankesteri* is inadequate but evidence available indicates a possibility, if not a probability, that two species at least from St. Thomas should be recognized, one with spermathecal pores in *ab* and gizzards in vii-ix, and another with spermathecal pores in *aa* near the midventral line and with gizzards in v-vii. All of the St. Thomas forms are distinguished from the Mexican species by the presence of a third gizzard.

1. *Trigaster lankesteri* Benham 1886.—St. Thomas. Known only from the original description.

2. *Trigaster intermedia* (or *calwoodi*) Michaelsen 1900.—St. Thomas. (Also *vide* Michaelsen 1899.)

3. *Trigaster tolteca* Eisen 1900.—Toluca, Mexico. Known only from the original description of the poorly preserved holotype, which was sectioned.

Genus DICHOGASTER Beddard 1888

The most recent key is that in Michaelsen, 1900.

1. *Dichogaster affinis* (Michaelsen) 1890.—Haiti (Michaelsen, 1903). St. Thomas (Michaelsen, 1908). Caves, Yucatan, Mexico (Pickford, 1938). Peregrine.

2. *Dichogaster bolaui* (Michaelsen) 1891.—San Francisco (*rugosa*, Eisen, 1896). Mexico (*palmicola*, Eisen, 1896, also Pickford, 1938). St. Tnomas (Micahelsen, 1898). Jamaica, Dominica, St. Vincent, Trinidad (Michaelsen, 1900). Panama (*var. octonephra* Cognetti 1905). Maiti (Michaelsen, 1908). Jamaica (Michaelsen, 1935). Synonymy according to Michaelsen 1900 and Pickford 1932 and 1938. Peregrine.

3. *Dichogaster gagzoi* Michaelsen 1908.—St. Marc, Haiti. Known only from the original description.

4. *Dichogaster godeffroyi* (Michaelsen) 1890. Puerto Plata, Dominican Republic. (*Vide* also Michaelsen, 1908 and 1936).

5. *Dichogaster greeffi* Michaelsen 1902.—St. Thomas. Known only from the original description.

6. *Dichogaster guatemalae* (Eisen) 1900.—Guatemala City. Known only from the original description of the holotype.

7. *Dichogaster hartmeyeri* Michaelsen 1908.—Blue Mts., Jamaica. Known only from the original description.

8. *Dichogaster hilaris* Cognetti 1904.—Rancho Redondo, Tablazo, Llano Grande, Costa Rica. (*Vide* also Cognetti 1907 and 1908.)

9. *Dichogaster jamaicae* (Eisen) 1900.— Jamaica. Known only from the original description of the holotpye.

10. *Dichogaster keiteli* (Michaelsen) 1898.—Port au Prince, Haiti. Known only from the original description.

11. *Dichogaster manni* Michaelsen 1935.—Riviere, Haiti. Known only from the original description.

12. *Dichogaster mexicana* (Rosa) 1891.—Ciudad Durango, Mexico. (*Vide* also Ude, 1893.)

13. *Dichogaster nana* (Eisen) 1896.—San Blas, Mexico. (*Vide* also Eisen, 1900.) Known only from the types.

14. *Dichogaster paessleri* Michaelsen 1910.—Manzanillo, Mexico. Known only from the original description.

15. *Dichogaster papillata* (Eisen) 1896. — Tepic, Mexico. Known only from the original description.

16. *Dichogaster picadoi* Michaelsen 1912.—Planton, Estrella, Costa Rica. Known only from the original description.

17. *Dichogaster pitahayana* Michaelsen 1912. — Pitahaya, Costa Rica. Known only from the original description.

18. *Dichogaster reichardti* Michaelsen 1908. — Jamaica. (Also *vide* Michaelsen 1935.)

19. *Dichogaster ribaucourti* Eisen 1900.—Mexico City. Known only from the original description of aclitellate types.

20. *Dichogaster saliens* (Beddard) 1893.—Del Monte, San Francisco, California (*crawi*, Eisen, 1900, p. 228). Synonymy according to Michaelsen, 1935 (Rev. Zool. Bot. Afr. 27). Peregrine.

21. *Dichogaster sporadonephra* Cognetti 1905. — Point Savannah, Rio Lana, Rio Cianati, Darien, Panama. Turrialba, Costa Rica (Cognetti, 1908). Oricuajo, Costa Rica (Michaelsen, 1912).

22. *Dichogaster townsendi* Eisen 1900.—Jamaica. Known only from the original description of the poorly preserved, aclitellate holotype half of which was sectioned.

23. *Dichogaster tristani* Cognetti 1907.— San José, Costa Rica. Known only from the original description.

24. *Dichogaster uhleri* Michaelsen 1935.—Grand' Anse, Haiti. Known only from the original description.

25. *Dichogaster vereus* Cognetti 1905.—Darien, Panama. Known only from the original description.

26. *Dichogaster vialis* Michaelsen 1912. — Huehuetenango, Guatemala. Known only from the original description.

27. *Dichogaster viridis* (Eisen) 1900.—Toluca and Mexico City. Known only from the original description.

Genus EUTRIGASTER Cognetti 1904

This genus is distinguished at present from *Dichogaster* only by the presence of a third gizzard, a situation apparently exactly paralleled by *Diplocardia-Zapocecia*. Michaelsen did not recognize the genus but Stephenson (1930) allows it. Only one species is known.

1. *Eutrigaster oraedivitis* Cognetti 1904.—Tablazo, Costa Rica. (*Vide* also Cognetti, 1905.)

GENUS DUBIUM ET SPECIES DUBIA MEGASCOLECIDARUM

1. *Lumbricus guildingi* Baird 1871.—St. Vincent. Possibly a *Dichogaster* (Michaelsen, 1900, p. 419).

Family OCNERODRILIDAE

KEY TO NORTH AMERICAN GENERA

1. *a.* One ventral calciferous sac, in ix ..... *Gordiodrilus*
   b. Two lateral calciferous sacs, in ix 2
2. *a.* Male pores on xvii, not proandric 3
   b. Male pores on xviii, proandric ..... *Eukerria*
3. *a.* Two gizzards, metandric ..... *Nematogenia*
   b. No gizzard, holandric ..... *Ocnerodrilus*

Genus EUKERRIA Michaelsen 1935

1. *Eukerria kükenthali* (Michaelsen) 1908.— St. Thomas. Peregrine.

2. *Eukerria mcdonaldi* (Eisen) 1893.—Miraflores and Santa Ana, Baja California. (*Vide* also Eisen, 1900.)

3. *Eukerria zonalis* (Eisen) 1893.—Miraflores, Baja California. Known only from the original description. The species from Lower California have been regarded as endemics but the proper home of the genus appears to be in Brazil and Paraguay and endemicity in North America seems to be doubtful.

Genus OCNERODRILUS Eisen 1878

Four subgenera, *Ocnerodrilus, Liodrilus, Ilyogenia* and *Haplodrilus* were recognized by Michaelsen in 1900 (p. 384) but *Haplodrilus* was later (1925) regarded as generically distinct in which Stephenson (1930) concurs. At present *Haplodrilus* is distinguished only by proandry (*Ocnerodrilus* being holandric). Only one species each of *Liodrilus* and *Ocnerodrilus* is known, the former bithecal with spermathecal pores on 7/8, the latter athecal. *Ilyogenia* is bithecal but the spermathecal pores are on 8/9. Michaelsen's key to *Ilyogenia* (1900, p. 379) includes all North American species except *occidentalis, sabanae* and *simplex*. It may be permissible to express a doubt as to the validity of some of criteria of specific distinctness used in connection with this group.

1. *Ocnerodrilus agricola* Eisen 1893.—Guatemala City. Known only from the original description.

2. *Ocnerodrilus beddardi* Eisen 1893.—San José del Cabo, Baja California. Known only from the original description.

3. *Ocnerodrilus calwoodi* Michaelsen 1899.—St. Thomas. Havana, Cuba (Michaelsen, 1923).

4. *Ocnerodrilus comondui* Eisen 1900. — Comondu, Baja California. Known only from the original description.

5. *Ocnerodrilus contractus* Eisen 1893.—Llano Grande, Guatemala. Known only from the original description.

6. *Ocnerodrilus guatemalae* Eisen 1893.—Tamaju, Guatemala. Known only from the types. (*Vide* Eisen, 1900.)

7. *Ocnerodrilus hendriei* Eisen 1893.—Santo Tomas, Guatemala. (*Vide* also Eisen, 1900.) Known only from the types.

8. *Ocnerodrilus limicola* Eisen 1893.—Antigua, Guatemala. (*Vile* also Eisen, 1900.) Known only from the types.

9. *Ocnerodrilus meximanus* Eisen 1900.—Mazatlan, Mexico. San Francisco (Var. *hawaiiensis*, Eisen, 1900).

10. *Ocnerodrilus occidentalis* Eisen 1878.—Fresno and San Francisco, California. Durango, Mexico (Eisen, 1893). Phoenix, Arizona (Eisen, 1900). St. Thomas (Michaelsen, 1908). Peregrine.

11. *Ocnerodrilus rosae* Eisen 1893.—San Antonio, Guatemala. Known only from the original description.

12. *Ocnerodrilus sabanae* Cognetti 1905.—Darien, Panama. Known only from the types.

13. *Ocnerodrilus santixavieri* Eisen 1900.—Loreto and San Xavier, Baja California. Miraflores, Lower California (Cernosvitov, 1936).

14. *Ocnerodrilus simplex* Cognetti 1904.—San Jose, Costa Rica. Known only from the original description.

15. *Ocnerodrilus sonorae* Eisen 1893.—San Miguel de Horcasitas, Sonora, Mexico. Known only from the original description.

16. *Ocnerodrilus taste* (Eisen) 1895.— Sierra el Taste, Pescadero, Miraflores, San Blas, Tepic, Morelos, Mexico City, Mexico. (*Vide* also Eisen, 1896 and 1900.)

17. *Ocnerodrilus tepicensis* (Eisen) 1896.—Tepic, Mexico. (*Vide* also Eisen, 1900.) Known only from the types.

18. *Ocnerodrilus tuberculatus* Eisen 1900.—Guatemala City. Known only from the original description of the holotype.

Genus NEMATOGENIA Eisen 1900

Stephenson (1930, p. 862) recognizes three species of this genus but states that *josephina* is "hardly more than a variety of *panamaensis*." American forms are assumed to be introductions from Africa presumably from a region including South Nigeria and Liberia.

1. *Nematogenia panamaensis* Eisen 1900.—Panama. Peregrine.

2. *Nematogenia josephina* Cognetti 1904.—San José, Costa Rica. (*Vide* also Cognetti, 1906.) Known only from the types.

Genus GORDIODRILUS Beddard 1892

1. *Gordiodrilus dominicensis* Beddard 1892.—Supposedly imported to Kew from Dominica. Known only from the types, which are said, somewhat doubtfully, to be athecal. If this is correct the absence of spermathecae may be an abnormality. In the original account there are contradictory statements as to the location of the prostatic pores but later (Beddard, 1901, p. 364) the correct location is said to be on xvii and xviii. Presumably introduced from Africa. (*Vide* Gates. On some peregrine species of earthworms, in press.)

Family EUDRILIDAE

Genus EUDRILUS E. Perrier 1871

1. *Eudrilus eugeniae* (Kinberg) 1867. — Panama (Eisen, 1900). St. Thomas (Michaelsen, 1899). Bermudas (Moore, 1902). Haiti and Trinidad (Michaelsen, 1908). Bahamas (Michaelsen, 1908 and 1921). Cuba (Michaelsen, 1935). Virgin Islands (Gates, in press). Bermudas (*erudiens*, Ude, 1893). Martinique, St. Pierre Miquelon (*lacazii* E. Perrier, 1872). Imported

to Paris with plants from the Antilles (*decipiens*, E. Perrier, 1871). Peregrine. (*Vide* also Gates. On some peregrine species of earthworms.)

Family GLOSSOSCOLEIDAE

KEY TO NORTH AMERICAN SUBFAMILIES

1. *a.* Spermathecae anterior to testis segments at least in part 2
   b. Spermathecae posterior to testis segments ..... *Microchaetinae*
2. *a.* One gizzard, calciferous glands present ..... *Glossoscolecinae*
   b. No gizzard, no calciferous glands ..... *Spartganophilinae*

Subfamily GLOSSOSCOLECINAE

KEY TO NORTH AMERICAN GENERA

1. *a.* Seminal vesicles lacking or short 2
   b. Seminal vesicles long, extending back through several segments 3
2. *a.* Proandric ..... *Andiodrilus*
   b. Holandric ..... *Onychochaeta*
3. *a.* Nephridia with terminal sphinters ..... *Pontoscolex*
   b. Nephridia lack terminal sphincters ..... *Diachaeta*

Genus ANDIODRILUS Michaelsen 1900

1. *Andiodrilus biolleyi* Cognetti 1904.—Rancho Redondo, Tablazo, Orosi, Costa Rica. (*Vide* also Cognetti, 1906, 1907, Michaelsen, 1912, Picado, 1913, and for typhlosole, Hertling, 1923.)

2. *Andiodrilus orosiensis* Michaelsen 1912.—Orosi, Costa Rica. Known only from the types. (*Vide* Michaelsen, 1918.)

Genus ONYCHOCHAETA Beddard 1891

KEY TO SPECIES OF ONYCHOCHAETA

Setae paired anteriorly and in regular ranks, no seminal vesicles ..... *elegans*
Setae irregularly placed throughout, seminal vesicles present ..... *windlei*

1. *Onychochaeta elegans* (Cognetti) 1905. — Point Savannah, Darien, Panama. (Also *vide* Michaelsen, 1917.) Var. *cubana* Michaelsen 1923. Rincon, Cuba.

2. *Onychochaeta windlei* (Beddard) 1890.—Bermuda. (Also *vide* Beddard, 1891, Michaelsen, 1897, Moore, 1902.) Rincon, Cuba (Michaelsen, 1923). Grand' Anse, Haiti (Michaelsen, 1935).

Genus PONTOSCOLEX Schmarda 1861

KEY TO SPECIES OF PONTOSCOLEX

1. *a.* Sexthecal 2
   b. Octothecal, spermathecal pores on 6/7-9/10 ..... *vandersleeni*
2. *a.* Spermathecal pores intersegmental 3
   b. Spermathecal pores segmental, on posterior margins of viii-x ..... *lilljeborgi*
3. *a.* Spermathecal pores in 6/7-8/9 ..... *corethrurus*
   Spermathecal pores in 7/8-9/10 ..... *hingstoni*

1. *Pontoscolex corethrurus* (Fr. Müller) 1861.—Mexico, Guatemala, San

Salvador (Eisen, 1896). Costa Rica, Panama (Cognetti, 1904, 1905, 1907, 1908). Haiti, San Domingo, St. Thomas (Michaelsen, 1908). Lower California (Cernosvitov, 1936). Jamaica (*arenicola*, Schmarda, 1861 and Beddard, 1892). Synonymy according to Michaelsen, 1918. (*Vide* also Gates. On some American and Oriental earthworms.) Peregrine.

2. *Pontoscolex lilljeborgi* Eisen 1896.—Antigua, Guatemala. Known only from the original description.

Genus DIACHAETA Benham 1886

KEY TO NORTH AMERICAN SPECIES OF DIACHAETA

Setae in regular longitudinal ranks ..... *barbadensis*
Setae not in regular longitudinal ranks ..... *thomasi*

1. *Diachaeta barbadensis* (Beddard) 1893.—Imported to Kew supposedly from Barbados. (*Vide* also Michaelsen, 1918.)

2. *Diachaeta thomasi* Benham 1886.—St. Thomas. Jamaica (*Trichochaeta hesperidum* Beddard 1893 and 1899, *D. littoralis* Beddard 1892). Trinidad (Michaelsen, 1918). Synonymy according to Michaelsen, 1918.

Subfamily SPARGANOPHILINAE

Some species are inadequately characterized and even the best known, *eiseni*, requires more accurate definition with regard to certain characteristics. The genus is tentatively defined as follows.—Male pores intra-clitellar, on or slightly behind 18/19. Setae lumbricine, dorsal setae of clitellar segments lost prior to maturity. Nephropores in region of *ab*. Dorsal pores lacking or restricted to a short region anterior to the clitellum. Prostomium zygolobous. Intestinal origin in ix, no gizzard, calciferous glands, sacs or typhlosole. Hearts lateral in vii-xi; no subneural or extra-oesophageal trunks but paired ventrolateral trunks on the parietes in ii-xii open into the ventral trunk in xiv. Excretory system meganephric, prior to maturity nephridia anterior to xiii are lost. Holandric, seminal vesicles in xi-xii. Spermathecae adiverticulate.

Michaelsen (1900, pp. 463-465) recognized four species with two uncertain varieties in *benhami* and two subspecies in *smithi*. Hague (1923)) placed *benhami* in the synonymy of *eiseni*. *S. smithi* and *sonomae* are inadequately characterized but may be specifically distinct. The genotype is known only from the description of worms collected in the Thames River, England, presumably after the importation from some region in America. A report of the occurrence of this species in Philadelphia (Moore, 1895) is considered to be erroneous, the original home of the species still unknown though presumably in America.

KEY TO SPECIES OF SPARGANOPHILUS

1. *a.* Spermathecal pores on 5/6-8/9 2
   b. Spermathecal pores on 6/7-8/9 3
2. *a.* Spermathecal pores on 6/7-8/9 in paired groups of two ..... *sonomae*
   b. Spermathecal pores on 6/7-8/9 in paired groups of four ..... *smithi*

3. *a.* Prostate-like glands present ..... *eisene*
b. Prostate-like glands lacking ..... *lamesis*

1. *Sparganophilus eiseni* Smith 1895.—Illinois. Florida (Smith, 1896 and Eisen, 1896). Michigan, Ohio and Ontario (Moore, 1906). Indiana (Heimburger, 1915). Rivers and lakes east of the Mississippi (Smith, 1915). Louisiana and Wisconsin (Hague, 1923). Massachusetts (Gates, 1935). Ohio (Olson, 1928). New York (Olson, 1940). Tepic, Mexico (*benhami*, Eisen, 1896). Guatemala City (*benhami guatemalensis*, Eisen, 1896). Clayton, Iowa (*benhami carneus*, Eisen, 1896). Synonymy according to Hague, 1923. (*Vide* also Gates. On some American and Oriental earthworms, in press.)

2. *Sparganophilus smithi* Eisen 1896.—San Francisco, California. Known only from the original description.

3. *Sparganophilus sonomae* Eisen 1896.—Sebastopol, California. Known only from the original description.

Subfamily DRILOCRIUS Michaelsen 1918

1. *Drilocrius alfari* (Cognetti) 1904.—San José, Costa Rica. (Also *vide* Cognetti, 1905, and Michaelsen, 1918.)

Family LUMBRICIDAE
Subfamily MICROCHAETINAE
Genus DRILOCRIUS Michaelsen 1918

The most recent key to North American forms is that of Smith (1917, p. 159). For state keys *vide* Olson 1928, 1936 and 1940 (Ohio, Missouri and New York) also Altman, 1936 (Washington). Many of the species are importations from Europe. Endemics are restricted to *Bimastos* and *Eisenia* but several are of doubtful status.

Genus EISENIELLA Michaelsen 1900

A suggestion by Smith (1917, p. 161) that this genus is distinguished from all other Lumbricids by location of the female pores slightly median to *a* rather than lateral to *b* apparently has been confirmed by Pool (1937).

1. *Eiseniella tetraedra* (Savigny) 1826.—Ontario, Quebec, Nova Scotia, New Brunswick, Massachusetts, New York, Pennsylvania, Ohio, Indiana, Illinois, Michigan, Colorado, Washington, California. Missouri, Connecticut (Pickford, in personal communication). Peregrine. Four formae are recognized in American material (Smith, 1917, and also *vide* Pool, 1937). Of especial interest in connection with this species may be mentioned the following.—Pool, G. 1937. *Eiseniella tetraedra*, Ein Beitrag zur vergleichenden Anatomie und Systematik der Lumbriciden. *Acta Zool.* 18. Gavrilov, G. 1939. Sur la reproduction de *Eiseniella tetraedra forma typica. Acta Zool.* 20.

Genus EISENIA Malmgren 1877

1. *Eisenia carolinensis* Michaelsen 1910. — Fayetteville, North Carolina.

Known only from the description of the holotype carried to Hamburg with plants.

2. *Eisenia foetida* (Savigny) 1826.—Greenland, Nova Scotia, New Brunswick, Quebec, Ontario, Vancouver, most of the states (Smith, 1917), Mexico, Guatemala, Bermudas. Peregrine.

3. *Eisenia lönnbergi* (Michaelsen) 1894. — Savannah, Georgia. Raleigh, North Carolina (Michaelsen, 1900). Riverdale, Maryland (Smith, 1924). Mt. Vernon, Virginia (Gates, 1929). Durham, North Carolina (Stephenson, 1933). Petersham, Massachusetts (Gates, 1935). Chapel Hill, North Carolina (Beers, 1938). Woodbridge, Mt. Carmel, Cockaponsett State Forest, Meshomasic State Forest, Connecticut (Pickford, in personal communication). Tennessee (Smith, *in lit.*)

4. *Eisenia pearsei* Stephenson 1933.—Durham, North Carolina. Types in the British Museum. Known only from the original description.

5. *Eisenia rosea* (Savigny) 1826.—Nova Scotia, New Brunswick, Ontario, Quebec, Maine, Massachusetts, New York, Ohio, Indiana, Illinois, Missouri, Louisiana, Georgia, Arizona, California. Lower California. Connecticut (Pickford, in personal communication). Peregrine.

6. *Eisenia veneta* (Rosa) 1886.—*F. hortensis* Michaelsen 1890. San Francisco, California. Urbana, Illinois. Cleveland, Ohio. Peregrine.

Genus DENDROBAENA Eisen 1874

1. *Dendrobaena octaedra* (Savigny) 1826.—Greenland, Newfoundland. Ohio, Illinois, Colorado, Washington. Mexico. Peregrine.

2. *Dendrobaena rubida* (Savigny) 1826.—White Mts., New Hampshire (Southern, 1910). Peregrine.

3. *Dendrobaena subrubicunda* (Eisen) 1874.—Newfoundland, Nova Scotia, New Brunswick, Quebec, Ontario, Massachusetts, New York, Ohio, Indiana, Illinois, Missouri, Colorado, California. Peregrine. A distinct species according to Ude but only a variety or forma of *rubida* according to Michaelsen. Pickford states *(in lit.)* that "the differences are negligible except for position of the tubercula pubertatis and I am inclined to follow Michaelsen."

Genus ALLOLOBOPHORA Eisen 1874

1. *Allobophora caliginosa* (Savigny) 1826.—Nova Scotia, New Brunswick, Quebec, Ontario, Massachusetts, New York, Ohio, Indiana, Illinois, Wisconsin, Missouri, Georgia, Arizona, California, Washington, Mexico, Costa Rica, Bermudas. Connecticut (Pickford, in personal communication). Peregrine. Two formae are recognized, differing from each other as to location of the tubercula.

2. *Allolobophora chlorotica* (Savigny) 1826).—Greenland, Nova Scotia,

New Brunswick, Ontario, Quebec, British Columbia, New York, Ohio, Indiana, Illinois, Missouri, District of Columbia, North Carolina, Colorado, California, Mexico, Guatemala, Bermudas. Connecticut (Pickford, in personal communication). Peregrine.

3. *Allolobophora longa* Ude 1885.—Grand Manan, Ontario, Maine, Indiana. Connecticut (Pickford, in personal communication). Peregrine.

Genus BIMASTOS Moore 1893

According to Smith (1917, p. 177) all North American species except *tenuis* are "presumably indigenous."

1. *Bimastos beddardi* (Michaelsen) 1894.—Ohio, Illinois, Michigan, Florida, Montana, Washington, California. Michaelsen thinks that this is *parvus* but Smith maintains that the two are distinct because of slight differences in extent of clitella although a greater difference in clitellar extent is recognized as only of varietal significance in case of *gieseleri-hempeli*.

2. *Bimastos ducis* Stephenson 1933.—Durham, North Carolina. Known only from the holotype which is in the British Museum.

3. *Bimastos gieseleri* (Ude) 1895.—New York, Ohio, Indiana, Illinois, Kansas, Missouri, Georgia, Florida, Texas. One variety, *hempeli* Smith 1915, is recognized but is distinguished from *tumidus* only by lack of a tetragonal cross section of the body.

4. *Bimastos heimburgeri* Smith 1928.—White Heath, Illinois. Known only from the original description.

5. *Bimastos longicinctus* Smith et Gittins 1915.—Urbana, Illinois. Cantwell Cliffs, Ohio (Olson, 1928).

6. *Bimastos palustris* Moore 1893.—Pennsylvania and New Jersey. Raleigh, North Carolina (Michaelsen, 1900). (*Vide* Moore, 1895 and Smith, 1924.)

7. *Bimastos parvus* (Eisen) 1874. — Massachusetts, New York, Ohio, Michigan, Kansas, Louisiana, California, Mexico, Guatemala, Costa Rica.

8. *Bimastos tenuis* (Eisen) 1874. — Alaska, British Columbia, Ontario, Maine, Massachusetts, New York, Pennsylvania, Ohio, Indiana, Illinois, Michigan, Missouri, Colorado, California, Washington, Mexico, Guatemala. Connecticut (Pickford in personal communication). North American material identified as *constrictus* belongs here according to Smith 1917.

9. *Bimastos tumidus* (Eisen) 1874.—New York, Ohio.

10. *Bimastos welchi* Smith 1917.—Manhattan, Kansas. Known only from the holotype.

11. *Bimastos zeteki* Smith et Gittins 1915. — Urbana, Illinois. Douglas Lake, Michigan (Smith, 1913). Keewanee, Culver and Summitville, Indiana

(Heimburger, 1915). Susquehanna River, New York (Michaelsen, 1921). Butler and Montgomery counties, Ohio (Olson, 1928), Cape Girardeau Jefferson, Osage, Marion and Adair counties, Missouri (Olson, 1936).

Genus OCTOLASIUM Örley 1885

1. *Octolasium lacteum* Örley 1881.—New York, Ohio, Illinois, Indiana, Missouri, Colorado, California, Mexico. Connecticut (Pickford, in personal communication). Peregrine.

Genus LUMBRICUS L.

1. *Lumbricus castaneus* (Savigny) 1826.—Newfoundland, Ontario, Massachusetts, New York, Mexico. Peregrine.

2. *Lumbricus festivus* (Savigny) 1826.—Nova Scotia, New Brunswick, Ontario, Quebec. Peregrine.

3. *Lumbricus rubellus* Hoffmeister 1843.—Newfoundland, Nova Scotia, New Brunswick, Ontario, Quebec, Massachusetts, New York, Ohio, Missouri, Michigan, Washington, Oregon, California. Peregrine.

4. *Lumbricus terrestris* L.—Newfoundland, Nova Scotia, New Brunswick, Ontario, Quebec, Maine, Massachusetts, Connecticut, New York, Maryland, District of Columbia, Ohio, Illinois, Missouri, Michigan, Minnesota, Colorado, Washington, Oregon, California, Mexico. Peregrine.

GENERA DUBIA ET SPECIES DUBIAE OLIGOCHAETORUM

1. *Hypogaeum hirtum* Savigny 1820.—Philadelphia. Known only from the original description.

2. *Lumbricus apii* Kinberg 1867.—San Francisco, California.

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The Trematodes of Reptiles, Part I,
Systematic Section*

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This is the first of a series of compilatory articles covering published information concerning reptilian trematodes. According to present plans later parts will contain an host catalogue,** an index of both valid and invalid specific names of the worms, and an extensive bibliography of the more recent literature covered by the series.

The following acknowledgments are gratefully made. Dr. E. W. Price of the United States Bureau of Animal Industry kindly supplied us with important suggestions concerning the taxonomy of certain of the trematodes and with information about some of the literature involved. Mr. Arthur Loveridge of the Museum of Comparative Zoology (Harvard College) and Dr. Karl P. Schmidt of the Field Museum of Natural History (Chicago) gave us extensive assistance relative to questions of synonymy regarding the names of reptilian hosts listed below.

The respective abbreviations, *Dist.*, *Monost.*, and *Amphist.* are used interchangeably for *Distoma* or *Distomum*, *Monostoma* or *Monostomum*, and *Amphistoma* or *Amphistomum*. Since both forms of each of the three terms in question have been extensively used and since in modern terminology they represent mere collective groups, not valid genera, we thought it unnecessary to trace and record the variations in spelling.

The Species of Reptilian Flukes in Systematic Outline

Phylum PLATYHELMINTHES Claus 1880
Class TREMATODA Rudolphi 1808
Subclass ASPIDOGASTREA Faust and Tang 1936
Order ASPIDOGASTRATA Faust 1932
Superfamily ASPIDOGASTROIDEA Nicoll 1935
Family ASPIDOGASTRIDAE Poche 1907
Genus ASPIDOGASTER von Baer 1826

Aspidogaster conchicola von Baer 1826.—*Aspidonotus c.* (B.) Keber 1851. From Pelecypoda in Eurasia and North America. Larva recorded from *Trionyx sinensis* in China—Faust 1922 a, b.

Genus COTYLASPIS Leidy 1857

Cotylaspis cokeri Barker and Parsons 1914a.—From *Graptemys geographica* in the United States.

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Cotylaspis lenoiri (Poirier 1886) Nickerson 1902.—*Aspidogaster l.* P., *Platyaspis l.* (P.) Monticelli 1892. From *Cyclanorbis senegalensis* and *Trionyx triunguis* in Africa.
Cotylaspis sinensis Faust and Tang 1936.—From *Trionyx sinensis* in China.
Cotylaspis stunkardi Rumbold 1928.—From *Chelydra serpentina* in North Carolina.

Genus LISSEMYSIA Sinha 1935

Lissemysia indica Sinha 1935.—From *Lissemys punctata* in India.

Genus LOPHOTASPIS Looss 1902

Lophotaspis interiora Ward and Hopkins 1931.—From *Macrochelys temminckii* in Arkansas.

Lophotaspis orientalis Faust and Tang 1936.—From *Trionyx sinensis* in China.

Lophotaspis vallei (Stossich 1899) Looss 1902.—*Aspidogaster v.* S., *Amphistoma v.* (S.) L. 1902; *L. adhaerens* L. 1901. From *Caretta caretta* in the Mediterranean Sea and the Gulf of Mexico. Recent study—Wharton 1939.

Subclass DIGENEA Carus 1863
Order FASCIOLATA Nicoll 1936
Superfamily ALLOCREADIOIDEA Nicoll 1935
Family ALLOCREADIIDAE Stossich 1904
Subfamily ALLOCREADIINAE Looss 1902
Genus CREPIDOSTOMUM Braun 1900

Crepidostomum cooperi Hopkins 1931.—*C. ambloplitis* H. 1931; *C. solidum* Van Cleave and Mueller 1932; *C. fausti* Hunninen and Hunter 1933. Adults from various fish and *Trionyx mutica* in North America. Life history—Hopkins 1934.

Crepidostomum serpentinum Talbot and Hutton 1935. Adults from *Natrix septemvittata* in the United States.

Genus KAURMA Chatterji 1936

Kaurma longicirra Chatterji 1936.—From *Lissemys punctata* in India.
Kaurma orientalis Yamaguti 1937b.—From *Trionyx japonica* in Japan.

Subfamily Undetermined
Genus LAURERIELLA Skrjabin 1914

Laureriella lateriporus Skrjabin 1914.—From *Chamaeleo* sp. in Africa.

Superfamily CLINOSTOMATOIDEA Dollfus 1931
Family BRACHYLAEMIDAE Joyeux and Foley 1930
Subfamily BRACHYLAEMINAE Joyeux and Foley 1930

Genus BRACHYLAEMUS Blanchard 1847
(*Brachylaima* Dujardin 1843, *Brachylaimus* Dujardin 1845)
Species Inquirendae

Dist. baraldii Sonsino 1892.—*D. (Brachylaimus) b.* S.—Stossich 1895. From *Coluber gemonensis* in Cantania.

Dist. monas Rudolphi 1819.—*D. (Brachylaimus) m.* R.—Parona 1896. From a coecilian and *Amphisbaena* sp. in Brazil.

Family LIOLOPIDAE Dollfus 1934
Subfamily LIOLOPINAE Odhner 1912a
Genus HARMOTREMA Nicoll 1914a

Harmotrema eugari Tubangui and Masilungan 1936.—From *Naja* sp. in the Philippine Islands.

Harmotrema infecundum Nicoll 1914a.—From *Grayia smythii* in Africa.
Harmotrema laticaudae Yamaguti 1933.—From *Laticauda laticauda* in Japan.
Harmotrema nicolii Mehra 1936.—From *Gavialis gangeticus* in India.
Harmotrema rudolphii Tugangui and Masiluñgan 1936. From *Crocodylus porosus* in the Philippine Islands.

Genus HELICOTREMA Odhner 1912a

Helicotrema asymetrica Travassos 1922.—*Helicometra a.* (T.) T. 1929. From *Iguana iguana* in Brazil.

Helicotrema magniovatum Odhner 1912a.—*Helicometra m.* (O.) Travassos 1929. From *Iguana iguana.*

Helicotrema spirale (Diesing 1850) Odhner 1912a.—*Monost. s.* D., *Dist. s.* (D.) Brandes 1892, *Helicometra s.* (D.) *Travassos* 1929. From *Iguana iguana, Podocnemis tracaxa,* and *Testudo tabulata* in Brazil.

Family NEPHROCEPHALIDAE Dollfus 1931
Subfamily NEPHROCEPHALINAE Travassos 1929
Genus NEPHROCEPHALUS Odhner 1902

Nephrocephalus sessilis Odhner 1902. From *crocodylus niloticus* in Sudan.

Genus ODHNERIOTREMA Travassos 1929

Odhneriotrema incommodum (Leidy 1856) McIntosh 1935.—*Monost. i.* L., *Dist. i.* (L.) L. 1891, *Homoscaphis i.* (L.) Canavan 1933; *Dist. oricola* L., 1884. From *Alligator mississipiensis* in Florida.

Odhneriotrema microcephala (Travassos 1922) Travassos 1929a.—*Nephrocephalus m.* T. From *Caiman crocodilus* in Brazil.

Superfamily DICROCOELIOIDEA Faust 1929
Family BRACHYCOELIIDAE Johnston 1913a
Subfamily BRACHYCOELIINAE Looss 1899
Genus BRACHYCOELIUM Dujardin 1845

Brachycoelium salamandrae (Frölich 1789) Rankin 1938.—Synonymy from R. 1938: *Fasciola s.* F., *Dist. s.* (F.) Zeder 1803; *D. crassicolle* Rudolphi 1809, *B. c.* (R.) Looss 1899, *Lecithodendrium c.* (R.) Stossich 1899; *B. daviesi* Harwood 1932; *B. dorsate* Byrd 1937c; *D. flavocinctum* von Linstow 1879; *B. georgianum* B. 1937c; *D. hospitale* Stafford 1900, *B. h.* (S.) L 1902; *B. louisianae* B. 1937c; *B. meridionalis* H. 1932; *B. mesorchium* B. 1937c; *B. obesum* Nicoll 1914a; *B. ovale* B. 1937c; *B. storeriae* H. 1932. From various amphibians and from *Anguis fragilis, Leiolopisma unicolor, Opheodrys aestivus, Ophisaurus ventralis,* and *Storeria dekayi* in Europe and North America.

Brachycoelium sp. Harwood 1932.—From *Opheodrys aestivus* in Texas.

Genus LEPTOPHALLUS Lühe 1909

Leptophallus nigrovenosus (Bellingham 1844) Lühe 1909.—*Dist. nigrovenosum* B., *Lecithodendrium nigrovenosum* (B.) Lühe 1899, *Brachycoelium nigrovenosum* (B.) Looss 1902; *D. n. natricis torquatae* Diesing 1855; *D. signatum* Dujardin 1845, *Caudorchis s.* (D.) Talbot 1934. From *Natrix chrysarga* and *N. natrix* in Europe.

Subfamily CYMATOCARPINAE Baer 1924
Genus CYMATOCARPUS Looss 1899

Cymatocarpus solearis (Braun 1899) Braun 1901.—*Dist. soleare* B. From *Chelonia mydas.*

Cymatocarpus undulatus Looss 1899.—From Caretta caretta in Egypt, Gulf of Persia, and (Linton 1910) Florida.

Subfamily ORCHIDASMATINAE Dollfus 1937
Genus ORCHIDASMA Looss 1900

Orchidasma amaphiorchis (Braun 1899) Braun 1901.—*Dist. a.* B., *Anadasmus a.* (B.) Looss 1899. From *Caretta caretta, C. olivacea, Chelonia mydas,* and *Podocnemis expansa* near Brazil, Florida, Italy, and Japan.

Family DICROCOELIIDAE Odhner 1910
Subfamily DICROCOELIINAE Looss 1899
Genus EUPARADISTOMUM Tubangui 1931

Euparadistomum varani Tubangui 1931.—From *Varanus salvator* in the Philippine Islands.

Genus EURYTREMA Looss 1907

Eurytrema travassosi Bhalerao 1936a.—*Euritrema parvum* Travassos 1916 not *Eurytrema parvum* Senoo 1908. From *Tupinambis teguixin* in Brazil.

Genus INFIDUM Travassos 1916

Infidum infidum (de Faria 1910) Travassos 1916.—*Dicrocoelium i.* F. From *Eunectes murinus* in Brazil.

Infidum luckeri McIntosh 1939b.—From *Dromicus hoodensis* on the Galapagos Islands.

Infidum similis Travassos 1916.—From *Drymobius bifossatus* in Brazil.

Genus PARADISTOMUM Kossack 1910

Paradistomum ceratophorae (Dollfus 1923) Bhalerao 1936a.—[*Paradistoma*] *c.* D., *Paradistoma c.* (D.) Woodcock 1925; *Paradistomum lanka* Fernando 1923. From *Ceratophora stoddarti* in Ceylon.

Paradistomum crucifer (Nicoll 1914a) Travassos 1919.—*Eurytrema c.* N. From *Delma fraseri* in Australia.

Paradistomum excalotes Tubangui and Masiluñgan 1935.—From *Calotes calotes* in the Philippine Islands.

Paradistomum geckonum Bhalerao 1929.—From *Gekko gecko* in Burma.

Paradistomum gregarinum Tubangui 1929.—*P. magnum* Tubangui 1928 not Travassos. From *Hemidactylus frenatus* and *H. gleadovii* in Burma and the Philippine Islands.

Paradistomum indicum (Narain and Das 1929) Bhalerao 1936a.—*Dicrocoelium indica* N. and D. From *Uromastix hardwickii* in India.

Paradistomum lutzi Travassos 1919.—From *Trimeresurus atrox* in South America.

Paradistomum maccallumi (Johnston 1932) Bhalerao 1936a.—*Paradistoma m.* J.; *Cephalogonimus trachysauri* MacCallum 1921. From *Trachysaurus rugosus* in Australia.

Paradistomum magnum Travassos 1919.—From *Philodryas schotti* in South America.

Paradistomum magnum oroterminosum Bhalerao 1929.—From *Mabuya dissimilis* in Burma.

Paradistomum moghei Bhalerao 1936a.—From *Calotes versicolor* in India.

Paradistomum mutabile (Molin 1859) Nicoll 1924.—*Dist. m.* M., *Dicrocoelium m.* (M.) Braun 1901, *Anchitrema m.* (M.) Rizzo 1902, *Paradistoma m.* (M.) Dollfus 1922. From *Lacerta agilis, L. muralis, Mabuya siamensis,* and *Tarentola mauritanica* in Italy and Indo-China.

Paradistomum orientalis (Narain and Das 1929) Bhalerao 1936a.—*Dicrocoelium o.* N. and D. From *Hemidactylus flaviviridis* in India.

Paradistomum paloensis Tubangui 1933.—From *Hydrosaurus pustulosus* in the Philippine Islands.

Paradistomum trachysauri (MacCallum 1921) Bhalerao 1929.—*Paragonimus t.* M., *Paradistoma t.* (M.) Johnston 1932. From *Trachysaurus rugosus* in Australia.

Paradistomum zonuri Malan 1939.—From *Cordylus cordylus* in South Africa.

Subfamily MESOCOELIINAE Dollfus 1929
Genus MESOCOELIUM Odhner 1910

Mesocoelium americanum Harwood 1932.—From *Eumeces fasciatus, Leiolopisma unicolor,* and *Storeria dekayi* in Texas.

Mesocoelium brevicaecum Ochi 1930.—From amphibians and *Elaphe quadrivirgata* and *Eumeces latiscutatus* in Asia.

Mesocoelium meggitti Bhalerao 1927a.—From *Maybuya dissimilis* and *M. multi-*

Mesocoelium danforthi Hoffman 1935.—From *Celestus pleii* in Porto Rico.

Mesocoelium geoemydae Ozaki 1936.—From *Geoemyda spengleri* in Japan.

Mesocoelium leiperi Bhalerao 1936a.—From *Natrix piscator* in Burma.

Mesocoelium meggitti Bhalerao 1927a—From *Maybuya dissimilis* and *M. multi-fasciata* in India and the Philippine Islands.

Mesocoelium microon Nicoll 1914b.—From frogs and *Tiliqua scincoides* in Australia.

Mesocoelium monodi Dollfus 1929.—From *Agama agama, A. planiceps, Chamaeleo gracilis, Mabuya maculilabris,* and *Riopa fernandi* in Africa.

Mesocoelium sociale (Lühe 1901) Odhner 1910.—*Dist. s.* L. From amphibians and (Chatterji 1940) *Ptyas mucosus* in India.

Genus PINTNERIA Poche 1907

Pintneria mesocoelium (Cohn 1903) nobis.—*Hoploderma m.* C. From *Draco volans* in Java.

Family LECITHODENDRIIDAE Odhner 1910
Subfamily ANCHITREMATINAE Mehra 1935
Genus ANCHITREMA Looss 1899

Anchitrema latum Gedoelst 1919.—From *Chamaeleo dilepis* in Belgian Congo.

Anchitrema sanguineum (Sonsino 1894) Looss 1899.—*Dist. s.* S. From *Chamaeleo basiliscus, C. chamaeleon,* and bats in Africa.

Anchitrema sokolowi (Skrjabin 1914) Dollfus 1929.—*Mesocoelium s.* S. From *Chamaeleo* sp. in Africa.

Subfamily EXOTIDENDRIINAE Mehra 1935
Genus EXOTIDENDRIUM Mehra 1935

Exotidendrium gharialii Mehra 1935.—From *Gavialis gangeticus* in India.

Subfamily LECITHODENDRIINAE Looss 1902
(*Lecithodendrinae* Lühe 1901)
Genus LECITHODENDRIUM Looss 1896

Lecithodendrium hirsutum (Looss 1896) Looss 1899.—Dist. h. L. From a chameleon in Egypt.

Lecithodendrium obtusum (Looss 1896) Looss 1899.—*Dist. o.* L. From *Chamaeleo basiliscus* in Egypt.

Lecithodendrium sp. Joyeux and Houdemer 1928.—From *Mabuya siamensis* in Indo-China.

Subfamily PALITREMATINAE nobis
(*Palitreminae* Gogate 1939)
Genus PALITREMA Gogate 1939

Palitrema macrorchis Gogate 1939.—From *Calotes versicolor* and *Hemidactylus brookii* in Rangoon.

Subfamily PLEUROGENETINAE Looss 1899
Genus PLEUROGENOIDES Travassos 1921b

Pleurogenoides medians (Olsson 1876) Travassos 1921.—*Dist. m.* O., *Pleurogenes m.* (O.) Looss 1899, *Dist. tacapense* Sonsino 1894, *Pleurogenes tacapensis* (S.) L. 1899. From various amphibians and *Chamaeleo chamaeleon* in Tunisia.

Pleurogenoides tener (Looss 1898) Travassos 1921b.—*Dist.* "*tacapense*" of Looss 1898 and *Pleurogenes* "*tacapense*" of Stossich 1899; *Dist. tenere* L., *Pleurogenes tener* (L.) L. 1898, *Dist. tenerum* L. 1899, *Prosotocus tener* (L.) L. 1899. From *Chamaeleo basiliscus* in Egypt.

Genus POSTORCHIGENES Tubangui 1928

Postorchigenes ovatus Tubangui 1928.—From *Hemidactylus frenatus* in the Philippine Islands.

Species Inquirendae in Dicrocoelioidea

Dist. arrectum Dujardin 1845.—*D. (Dicrocoelium) a.* D.—Stossich 1895. From *Lacerta muralis* and *L. viridis* in France.

Dist. (Dicrocoelium) assula Dujardin 1845.—From *Natrix natrix* in France.

Superfamily ECHINOSTOMATOIDEA Faust 1929
Family COTYLOTRETIDAE Travassos 1922
Genus COTYLOTRETUS Odhner 1902

Cotylotretus rugosus Odhner 1902.—From *Spilotes pullatus.*

Family ECHINOSTOMATIDAE Poche 1926
(*Echinostomidae* Looss 1902)
Genus ALLECHINOSTOMUM Odhner 1910

Allechinostomum crocodili (Poirier 1886) Odhner 1910.—*Dist. c.* P., *Echinostoma*

c. (P.) Stossich 1895, *Echinostomum* c. (P.) Odhner 1902, *Echinostomum umbonatum* O. 1902. From *Crocodylus niloticus* in Africa and from *C. siamensis*.

Genus ECHINOSTOMA Rudolphi 1809

Echinostoma jacarétinga de Freitas and Lent 1938a.—From *Caiman crocodilus* in Brazil.

Genus PARYPHOSTOMUM Dietz 1909

Paryphostomum indicum Bhalerao 1931b.—From *Uromastix hardwickii* in India.

Genus STEPHANOPRORA Odhner 1902

Stephanoprora ornata Odhner 1902.—*Echinostomum ornatum* (O.) O. 1910. From *Crocodylus niloticus* in Egypt.

Genus TESTISACULUS Bhalerao 1927a

Testisaculus indicus Bhalerao 1927a.—From *Uromastix hardwickii* in India.

Superfamily FASCIOLOIDEA Stiles and Goldberger 1910
Family FASCIOLIDAE Railliet 1895
Subfamily OMPHALOMETRINAE Looss 1899
Genus PULCHROSOMOIDES de Freitas and Lent 1937

Pulchrosomoides elegans de Freitas and Lent 1937.—From *Iguana iguana* in Brazil.

Family PLEORCHIIDAE nobis
(*Pleorchidae* Poche 1926)
Genus PLEORCHIS Railliet 1896

Pleorchis mollis (Leidy 1856) Stiles 1896.—*Monost. molle* L., *Polyorchis molle* (L.) Monticelli 1896. From *Sternotherus odoratus* in the United States.

Superfamily HAPLOPOROIDEA Nicoll 1935
Family ZOOGONIDAE Odhner 1911a
Subfamily ZOOGONINAE Odhner 1902
Genus ZOOGONOIDES Odhner 1902

Zoogonoides boae MacCallum 1921.—From *Constrictor constrictor* in Brazil.

Superfamily HEMIUROIDEA Faust 1929
Family AZYGIIDAE Odhner 1911b
Genus PROTEROMETRA Horsfall 1933

Proterometra sagittaria Dickerman 1937.—*Cercaria s.* D. Adults "developed experimentally in fish and turtles."

Family HALIPEGIDAE Poche 1926
Genus HALIPEGUS Looss 1899

Halipegus dubius Klein 1905—From *Ptyas dipsas*.

Halipegus kessleri (Grebnitzky 1872) Wlassenko 1929.—*Dist. k.* G. From frogs and *Natrix natrix* in Russia. According to Ingles 1936 *H. k.* and *H. rossicus* Isaichikov and Zakharov 1929 are varieties of *H. ovocaudatus* (Vulpian 1858) Looss 1899 [= *D. ovocaudatum* V. and *Cercaria cystophora* Wagener 1866].

Genus VITELLOTREMA Guberlet 1928

Vitellotrema fusipora Guberlet 1928.—From *Farancia abacura* in the United States.

Family HEMIURIDAE Lühe 1901
Subfamily HEMIURINAE Looss 1899
Genus HEMIURUS Rudolphi 1809

Hemiurus sp. Johnston 1912.—*Apoblema* sp. J. 1910. From *Denisonia superba* and *Pseudechis porphyriacus* in Australia.

Subfamily STERRHURINAE Looss 1907
Genus LECITHOCHIRIUM Lühe 1901

Lecithochirium dillanei Nicoll 1918b.—From *Distiera* sp. in Australia.

Superfamily HERONIMOIDEA nobis
(*Heronimoinae* Poche 1926)
Family HERONIMIDAE Ward 1917
Genus HERONIMUS MacCallum 1902

Heronimus chelydrae MacCallum 1902.—*Aorchis extensus* Barker and Parsons 1914; *H. geomydae* M. 1921; *H. maternum* M. 1921. From *Chelydra serpentina, Chrysemys picta, Emys blandingii, Geoemyda punctularia, Graptemys geographica, Kinosternon hirtipes, K. subrubrum, Pseudemys scripta,* and *Sternotherus odoratus* in North America and on Trinidad Island. See Caballero 1940.

Superfamily HETEROPHYOIDEA Faust 1929
Family SIGMAPERIDAE nobis
Subfamily SIGMAPERINAE Poche 1926
Genus SIGMAPERA Nicoll 1918b

Sigmapera cincta Nicoll 1918b.—From *Emydura latisternum* in Australia. Poche 1926 and Ciurea 1933 include the Sigmaperinae in the family Heterophyidae Odhner 1914 but this arrangement is not accepted by Witenberg 1929 and Price 1940.

Superfamily NOTOCOTYLOIDEA Nicoll 1935
Family PRONOCEPHALIDAE Looss 1902
Subfamily CHARAXICEPHALINAE Price 1931
Genus CHARAXICEPHALUS Looss 1901

Charaxicephalus robustus Looss 1901.—From *Chelonia mydas* near Egypt.

Genus DESMOGONIUS Stephens 1911

Desmogonius desmogonius Stephens 1911.—From *Chelonia mydas* near Nicaragua.

Genus DIASCHISTORCHIS Johnston 1913b

Diaschistorchis ellipticus (Pratt 1914) Price 1931.—*Wilderia elliptica* Pratt. From *Caretta caretta* in the Gulf of Mexico. Mehra 1932b considers *D. e.* to be a synonym of *D. pandus.*

Diaschistorchis gastricus Mehra 1932b.—From *Hardella thurgi, Kachuga dhongoka, K. smithii,* and *K. tectum* in India.

Diaschistorchis lateralis Oguro 1936.—From *Chelonia japonica* near Japan.

Diaschistorchis pandus (Braun 1901) Johnston 1913b.—*Monost. pandum* B.; *Synechorchis megas* Barker 1922. From *Caretta caretta, Chelonia mydas,* and *Eretmochelys imbricata* near Australia, Bermuda Islands, Cuba, Italy, and Japan.

Diaschistorchis takahashii Fukui and Ogata 1936b.—From *Ocadia sinensis* in Japan. See F. and O. 1939.

Subfamily NEOPRONOCEPHALINAE Mehra 1932b
Genus NEOPRONOCEPHALUS Mehra 1932b

Neopronocephalus gangeticus Mehra 1932b.—From *Kachuga dhongoka* in India.

Neopronocephalus mehri Chatterji 1936.—From *Morenia ocellata* in India.

Neopronocephalus triangularis Mehra 1932b.—From *Kachuga dhongoka* in India.

Subfamily PRONOCEPHALINAE Looss 1899
Genus ADENOGASTER Looss 1901

Adenogaster serialis Looss 1901.—From *Caretta caretta* near Egypt.

Genus ASTRORCHIS Poche 1926

Astrorchis renicapite (Leidy 1856) Poche 1926.—*Monost. r.* L.; M. *nephrocephalum* Diesing 1858; *M. sphargidis* MacCallum 1921. From *Dermochelys coriacea* near Massachusetts and Tunisia.

Genus CRICOCEPHALUS Looss 1899

Cricocephalus albus (Kuhl and van Hasselt 1822) Looss 1899.—*Monost. album* K. and H.; *C. delitescens* L. 1899; *C. koidzumi* Kokayashi 1915. From *Caretta caretta* near Florida (Linton 1910), *Chelonia japonica* near Japan, *C. mydas* near Singapore and in the Mediterranean Sea, and *Eretmochelys imbricata* near Australia.

Cricocephalus megastomus Looss 1902.—From *Chelonia mydas* near Egypt.
Cricocephalus resectus Looss 1902.—From *Chelonia mydas* near Egypt.
Cricocephalus ruber (Kuhl and van Hasselt 1822) Looss 1899.—*Monost. rubrum* K. and H. From *Chelonia mydas* near "Isles des Cocotiers."

Genus EPIBATHRA Looss 1902

Epibathra crassa (Looss 1901) Looss 1902.—*Glyphicephalus crassus* L. From *Caretta caretta* near Egypt.

Genus GLYPHICEPHALUS Looss 1901

Glyphicephalus lobatus Looss 1901.—From *Chelonia mydas* near Egypt.
Glyphicephalus solidus Looss 1901.—From *Chelonia mydas* near Egypt.

Genus MACRAVESTIBULUM Mackin 1930

Macravestibulum eversum Hsü 1937.—From *Graptemys geographica* in Michigan.
Macravestibulum obtusicaudum Mackin 1930.—From *Pseudemys scripta* in Oklahoma.

Genus MEDIOPORUS Oguro 1936

Medioporus cheloniae Oguro 1936.—From *Chelonia japonica* in Japan.
Medioporus macrophallus Oguro 1936.—From *Eretmochelys imbricata* in Japan.

Genus PLEUROGONIUS Looss 1901

Pleurogonius bilobus Looss 1901.—From *Chelonia mydas* near Egypt.
Pleurogonius linearis Looss 1901.—From *Chelonia japonica* near Japan and *C. mydas* near Egypt.
Pleurogonius longiusculus Looss 1901.—*Monost. "trigonocephalum"* of van Beneden 1859. From *Chelonia mydas* near Egypt.
Pleurogonius minutissimus Looss 1901.—From *Chelonia mydas* near Egypt.
Pleurogonius ozakii Oguro 1936.—From *Eretmochelys imbricata* near Japan.
Pleurogonius trigonocephalus (Rudolphi 1809) Looss 1901.—*Monost. t.* R.; *Planaria mydae* Braun in R. 1809. From *Caretta caretta* near Florida and from *Eretmochelys imbricata* near Australia.

Genus PRONOCEPHALUS Looss 1899

Pronocephalus obliquus Looss 1901.—*Monost. "trigonocephalus"* and *P. t.* of Looss 1899. From *Chelonia japonica* near Japan.

Genus PYELOSOMUM Looss 1899

Pyelosomum cochlear Looss 1899.—From *Chelonia mydas* near Egypt.
Pyelosomum longicaecum Luhman 1935.—From *Caretta caretta* near Florida.
Pyelosomum posterorchis Oguro 1936.—From *Eretmochelys imbricata* near Japan.

Subfamily TELOPORIINAE Stunkard 1934
(Teloporidae Fukui 1933, Teloporiidae Nicoll 1935)
Genus TELOPORIA Fukui 1933

Teloporia aspidonectes (MacCallum 1917) Fukui 1933.—*Paramphistomum a.* M., *Opisthoporus a.* (M.) F. 1929. From *Trionyx ferox* and *T. spinifera* in the United States.

Superfamily OPISTHORCHIOIDEA Vogel 1934
(*Opisthorchoidea* Faust 1929)
Family ACANTHOSTOMATIDAE Nicoll 1935
(*Acanthostomidae* Poche 1926)
Subfamily ACANTHOSTOMATINAE nobis
(*Acanthostominae* Nicoll 1914)
Genus ACANTHOSTOMUM Looss 1899

Acanthostomum atae Tubangui and Masiluñgan 1936.—From *Crocodylus porosus* in the Philippine Islands.
Acanthostomum coronarium (Cobbold 1861) Looss 1899.—*Dist. c.* C., *Anoiktostoma c.* (C.) Stossich 1899, *Acanthochasmus coronarius* (C.) Braum 1901. From *Alligator mississipiensis* and *Crocodylus acutus* in North America.

Acanthostomum diploporum (Stunkard 1931) Stunkard 1938.—*Acanthochasmus diploporus* S. From *Alligator mississipiensis* in the United States.

Acanthostomum elongatum Tubangui and Masiluñgan 1936.—From *Crocodylus porosus* in the Philippine Islands.

Acanthostomum productum (Odhner 1902) nobis.—*Acanthochasmus productus* O. From *Crocodylus niloticus* in Sudan.

Acanthostomum quaesitum (Nicoll 1918b) nobis.—*Acanthochasmus quaesitus* N. From *Crocodylus johnstoni* in Australia.

Acanthostomum marajoarum (de Freitas and Lent 1938) nobis.—*Caimanicola m.* F. and L. From *Caiman crocodilus* in Brazil. See Price 1940.

Acanthostomum scyphocephalum (Braun 1899) nobis.—*Dist. s.* B., *Acanthochasmus scyphocephalus* (B.) B. 1901; *Monost. testudinis* B. 1899. From *Chelys fimbriata* in Brazil.

Acanthostomum vicinum (Odhner 1902) nobis.—*Acanthochasmus vicinus* O. From *Crocodylus niloticus* in Sudan.

Genus ATROPHECAECUM Bhalerao 1940

Atrophecaecum burminis (Bhalerao 1926) Bhalerao 1940.—*Acanthochasmus b.* B., *Acanthostomum b.* (B.) B. 1936. From *Natrix piscator* in India.

Family CRYPTOGONIMIDAE Ciurea 1933

Subfamily NEOCHASMINAE Van Cleave and Mueller 1932

Genus NEOCHASMUS Van Cleave and Mueller 1932

Neochasmus labeosus Bennett 1935.—*N l.* B. 1933—nomen nudum. From *Natrix rhombifera* in Louisiana.

Family OPISTHORCHIIDAE Braun 1901
(*Opisthorchidae* Lühe 1901)

Subfamily OESOPHAGICOLINAE Yamaguti 1933

Genus OESOPHAGICOLA Yamaguti 1933

Oesophagicola laticaudae Yamaguti 1933. From *Laticauda laticauda* in Japan.

Subfamily OPISTHORCHIINAE Looss 1899

Genus CYCLORCHIS Lühe 1908

Cyclorchis amphileucus (Looss 1896) Lühe 1908.—*Dist. amphileucum* L., *Opisthorchis amphileuca* (L.) Kowalewski 1898, *Metorchis amphileucus* (L.) L. 1902. From *Naja haje* in Egypt.

Cyclorchis varani Price 1936c. From *Varanus niloticus* in Africa.

Genus OPISTHORCHIS Blanchard 1895

Opisthorchis ophidiarum Tubangui and Masiluñgan 1935.—From *Lapemis hardwickii* in the Philippine Islands.

Opisthorchis ovalis Barker 1911.—From *Trionyx mutica* and *T. spinifera* in the United States.

Subfamily RATZIINAE Price 1940
(*Ratzinae* Dollfus 1929b)

Genus RÁTZIA Poche 1926

Rátzia parva (Stossich 1904) Poche 1926.—*Brachymetra p.* S.; *Opisthorchis joyeuxi* Brumpt 1922. Metacercaria from amphibians (Joyeux, du Noyer, and Baer 1930; Wisniewski 1933); adult from *Coluber hippocrepis* in Africa.

Superfamily PARAMPHISTOMATOIDEA Faust 1929
(*Paramphistomoidea* Stiles and Goldberger 1910)

Family ANGIODICTYDIAE Looss 1902

Subfamily ANGIODICTYINAE Poche 1926

Genus ANGIODYCTYUM Looss 1902

Angiodictyum parallelum (Looss 1901) Looss 1902.—*Microscaphidium p.* L. From *Chelonia mydas* near Egypt.

Genus DEUTEROBARIS Looss 1900

Deuterobaris proteus (Brandes 1891) Looss 1902.—*Monost. p.* B., *Notocotyle p.* (B.) Monticelli 1892, *Baris p.* (B.) L. 1899. From *Chelonia mydas* in the Mediterranean Sea.

Genus MICROSCAPHIDIUM Looss 1900

Microscaphidium aberrans Looss 1902.—From *Chelonia mydas* near Egypt.

Microscaphidium reticulare (van Beneden 1859) Looss 1901.—*Monost. r.* B., *Microscapha reticularis* (B.) Looss 1899. From *Chelonia mydas* near Egypt.

Genus OCTANGIOIDES Price 1937

Octangioides skrjabini Price 1937.—From *Dermatemys mawii* in Mexico.

Genus OCTANGIUM Looss 1902

Octangium hasta Looss 1902.—From *Chelonia mydas* near Egypt.

Octangium sagitta (Looss 1899) Looss 1902.—*Microscapha s.* L., *Microscaphidium s.* (L.) L. 1901. From *Chelonia mydas* near Australia and Egypt.

Octangium takanoi Kobayashi 1920.—From *Chelonia mydas* near Singapore.

Genus POLYANGIUM Looss 1902

Polyangium linguatula (Looss 1899) Looss 1902.—*Microscapha l.* L.; *Monost. "reticulare"* of Walter 1893, not *M. r.* van Beneden. From *Chelonia mydas* near Australia and in the Mediterranean Sea.

Polyangium miyajimai Kobayashi 1915.—From *Chelonia mydas* in the Mediterranean Sea and from near Singapore. See K. 1920.

Family METACETABULIDAE de Freitas and Lent 1938b
Genus METACETABULUM de Freitas and Lent 1938b

Metacetabulum invaginatum de Freitas and Lent 1938b.—From *Chelonia mydas* in Brazil.

Family PARAMPHISTOMATIDAE Goto and Matsudaira 1918
(*Paramphistomidae* Fischoeder 1901)
Subfamily CLADORCHIINAE nobis *
(*Cladorchinae* Fischoeder 1901)
Genus ALLOSOSTOMA Stunkard 1916

Allosostoma magnum Stunkard 1916.—From *Pseudemys scripta* in North America.

Genus ALLOSOSTOMOIDES Stunkard 1924

Allosostomoides parvum (Stunkard 1916) Travassos 1934.—*Allosostoma p.* S.; *Paramphistomum chelydrae* MacCallum 1918; probably *Cercaria inhabilis* Cort 1914 and *C. convoluta* Faust 1919—Beaver 1929. From *Chelydra serpentina, Chrysemys picta,* and *Pseudemys floridana* in North America.

Genus CHIORCHIS Fischoeder 1901

Chiorchis purvisi Southwell and Kirschner 1937.—From *Geoemyda grandis* in Malaysia.

Genus HALLTREMA Lent and de Freitas 1939

Halltrema avitellina Lent and de Freitas 1939.—From *Podocnemis expansa* in Brazil.

Genus NEMATOPHILA Travassos 1934

Nematophila grande (Diesing 1839) Travassos 1934.—*Amphist.* g. D. From *Chelys fimbriata, Hydraspis geoffroyana, H. gibba, H. schoepfii, Podocnemis dumeriliana, P. expansa, P. tracaxa,* and *Rhinemys nasuta* in the Amazon valley.

* Southwell and Kirschner 1937 have proposed to suppress the names *Allosostoma, Allosostomoides, Nematophila, Ophioxenos, Schizamphistomum,* and *Schizamphistomoides* as synonyms of *Chiorchis* but new combinations of the specific names involved were not made.

Genus OPHIOXENOS Sumwalt 1926

Ophioxenos dienteros Sumwalt 1926.—From *Thamnophis ordinoides* and *T. sirtalis* in Washington (State).

Genus SCHIZAMPHISTOMOIDES Stunkard 1925

Schizamphistomoides constrictus Price 1936c.—From *Pelomedusa subrufa* in Tanganyika.

Schizamphistomoides spinulosum (Looss 1901) Stunkard 1925.—*Amphist. s.* L., *Paramphistomum s.* (L.) Gohar 1934. From *Chelonia mydas* in the Mediterranean Sea.

Schisamphistomoides tabascensis Caballero and Sokoloff 1934.—From *Dermatemys mawii* in Mexico.

Genus SCHIZAMPHISTOMUM Looss 1912

Schizamphistomum scleroporum (Creplin 1844) Looss 1912.—*Amphist. s.* C., *Schizamphistoma s.* (C.) Fukui 1929; *Paramphistomum papillostomum* MacCallum 1916, *P. papillosum* Stunkard 1926. From *Caretta caretta* and *Chelonia mydas* in the Mediterranean Sea and Atlantic Ocean and from near Australia.

Subfamily DIPLODISCINAE Cohn 1904

Genus CATADISCUS Cohn 1904

Catadiscus dolichocotyle (Cohn 1903) Cohn 1904.—*Amphist. d.* C. From *Chironius fuscus* in South America.

Genus DERMATEMYTREMA Price 1937

Dermatemytrema trifoliata Price 1937.—From *Dermatemys mawii* in Mexico.

Subfamily ZYGOCOTYLINAE Ward 1917

Genus STUNKARDIA Bhalerao 1931b

Stunkardia dilmphosa Bhalerao 1927a.—From *Batagur baska* and *Morenia ocellata* in India. See B. 1931b.

Species Inquirendae in Paramphistomatoidea

Amphist. cheloniae-imbricatae Diesing 1858.—From *Eretmochelys imbricata* in Ireland.

Amphist. sp. Krefft 1871.—From *Elseya dentata* in Australia.

Diplodiscus conicum Polonio 1859.—From *Natrix chrysarga* in Italy.

Superfamily PLAGIORCHIOIDEA Dollfus 1930

Family CALLODISTOMATIDAE nobis

(*Callodistomidae* Poche 1926)

Subfamily CALLODISTOMATINAE nobis

(*Callodistominae* Odhner 1910)

Genus BRAUNOTREMA Price 1930

Braunotrema pulvinata (Braun 1899) Price 1930.—*Dist. pulvinatum* B., *Thaumatocotyle pulvinata* (B.) Odhner 1910. From *Podocnemis expansa* in Brazil.

Family CALYCODIDAE Dollfus 1929c

Genus CALYCODES Looss 1901

Calycodes anthos (Braun 1899) Looss 1901.—*Dist. a.* B. From *Chelonia mydas* in Egypt and from "cheloniae" in Japan.

Family CEPHALOGONIMIDAE Nicoll 1915

Subfamily CEPHALOGONIMINAE Looss 1899

Genus CEPHALOGONIMUS Poirier 1886

Cephalogonimus amphiumae Chandler 1923.—Synonyms according to Bhalerao 1936b: *C. magnus* Sinha 1932; *C. gangeticus* Pande 1932. From a urodele in the United States and from *Trionyx gangetica* and *Lissemys punctata* in India.

Cephalogonimus burmanica Chatterji 1936.—From *Lissemys punctata* in Burma.

Cephalogonimus compactus Stunkard 1924.—From *Pseudemys floridana* in Florida.

Cephalogonimus emydalis Moghe 1930.—From *Lissemys punctata* in India.

Cephalogonimus japonicus Ogata 1934b.—From *Trionyx japonica* in Japan.

Cephalogonimus lenoiri Poirier 1886.—From *Trionyx triunguis* and *Cyclanorbis senegalensis* in Africa.

Cephalogonimus mehri Pande 1932.—From *Lissemys punctata* in India.

Cephalogonimus minutum Mehra 1937.—From *Lissemys punctata* in India.

Cephalogonimus vesicaudus Nickerson 1912.—From "*Aspidonectes*" and "*Amyda*" in the Mississippi River.

Cephalogonimus sp. Lühe 1911.—From *Natrix natrix* in Europe.

Family GORGODERIDAE Looss 1902
Subfamily GORGODERINAE Looss 1899
Genus PHYLLODISTOMUM Braun 1899

Phyllodistomum cymbiforme (Rudolphi 1819) Braun 1899.—*Dist. c.* R., *Spathidium c.* (R.) Looss 1899, *Plesiochorus cymbiformis* (R.) Looss 1901. From *Caretta caretta* and *Chelonia mydas* in Egypt, Florida, and Italy.

Family HAPLOMETRIDAE McMullen 1937
Subfamily HAPLOMETRINAE Pratt 1902
Genus MACRODERA Looss 1899

Macrodera longicollis (Abildgaard 1788) Lühe 1909.—*Fasciola l.* A., Dist. longicolle (A.) Cobbold 1860; *D. attenuatum* Rudolphi 1814; *D. naja* R. 1819, *M. n.* (R.) Looss 1899, *Saphedera n.* (R.) L. 1902, *D. naia* Dujardin 1845; *D. colubri natricis pulmonale* R. 1809; *D. pulmonalis c. n.* Viborg 1795. From *Coluber gemonensis, Natrix chrysarga,* and *N. natrix* in Europe; and from an "adder" in North Caucasus—Dinnik 1928.

Macrodera cantonensis (Wallace 1936) nobis.—*Saphedera c.* W. From *Natrix piscator* in China.

Family OMMATOBREPHIDAE Poche 1926
Genus OMMATOBREPHUS Nicoll 1914a

Ommatobrephus lobatum Mehra 1928a.—*O. folium* Thapar and Ali 1929a. From *Ptyas mucosus* and *Varanus bengalensis* in India.

Ommatobrephus lobatum najii Mehra 1931a.—From *Naja naja* in India.

Ommatobrephus singularis Nicoll 1914a.—From *Uromastix acanthinurus* in northern Africa.

Family PLAGIORCHIIDAE Ward 1917
(*Plagiorchidae* Lühe 1901)
Subfamily ENCYCLOMETRINAE Nicoll 1932
(*Encyclometriinae* Mehra 1931b)
Genus ENCYCLOMETRA Baylis and Cannon 1924

Encyclometra asymmetrica Wallace 1936.—From *Enhydris chinensis, E. plumbea, Natrix piscator, N. stolata, Ptyas korros,* and *P. mucosus* in China.

Encyclometra colubri-murorum (Rudolphi 1819) Dollfus in Joyeux and Houdemer 1928.—*Dist. c. m.* R.; *D. allostomum* Diesing 1850; *D. caudatum* Polonio 1859, *E. caudata* (P.) D. in J. and H. 1928; *D.* sp. no. 1 Timotheev 1900; *Odhneria bolognensis* Baer 1924; *E. b.* (B.) Baylis and Cannon 1924; *Paraplagiorchis timotheevi* Dollfus 1924a; *Orthorchis natricis* Mödlinger 1924, *E. natricis* B. and C. 1924; *D. subflavum* Sonsino 1892, *E. subflava* (S.) Dollfus 1924c. From *Coluber gemonensis, Natrix chrysarga, N. natrix, N. piscator,* and *Ptyas mucosus* in Europe and Asia.

Encyclometra japonica Yoshida and Ozaki 1929.—From *Elaphe quadrivirgata* (experimentally) and *Natrix tigrina* in Japan.

Encyclometra microrchis Yamaguti 1933.—From *Enhydris plumbea* in Japan.

Subfamily LEPTOPHYLLINAE Byrd, Parker, and Reiber 1940a
Genus LEPTOPHYLLUM Cohn 1902

Leptophyllum ovalis Byrd and Roudabush 1939.—From *Natrix taxispilota* in Florida.

Leptophyllum stenocotyle Cohn 1902.—From *Chironius fuscus* in South America.

Leptophyllum tamiamiensis McIntosh 1939a.—From *Agkistrodon piscivorus* in Florida.

Genus PAUROPHYLLUM Byrd, Parker, and Reiber 1940a

Paurophyllum megametricus Byrd, Parker, and Reiber 1940a.—From *Agkistrodon piscivorus* in Florida.

Paurophyllum simplexus Byrd, Parker, and Reiber 1940a.—From *Lamprepeltis getulus* in Florida.

Subfamily OPISTHOGONIMINAE Travassos 1929a
Genus OPISTHOGONIMUS Lühe 1900

Opisthogonimus afranioi Pereira 1929b.—From *Chironius carinatus*, *Philodryas schotti*, and *Trimeresurus neuwiedii* in Brazil.

Opisthogonimus interrogativus (Nicoll 1914a) Pereira 1929b.—*Opisthogenes i.* N. From *Philodryas schotti* in South America.

Opisthogonimus megabothrium Pereira 1928b.—From *Liophis merremii* in Brazil.

Opisthogonimus philodryadum (West 1895) Lühe 1900.—*Dist. p.* W.; *O. lecithonotus* L. 1900; *Dist. xenodontis* Cordero and Vogelsang 1928, *Opithogeners x.* (C. and V.) Price 1929. From "*Coluber eririo*," *Phylodryas schotti*, *Xenodon merremii*, and (Travassos 1941) "*Bothrops* sp." in South America.

Subfamily PLAGIORCHINAE Pratt 1902
(*Plagiorchinae* Lühe 1901)
Genus ASTIOTREMA Looss 1900

Astiotrema amydae Ogata 1938a.—From *Trionyx sinensis* in Korea.

Astiotrema elongatum Mehra 1931c.—From *Trionyx gangetica* in India.

Astiotrema emydis Ejsmont 1930.—From *Emys orbicularis* in Poland.

Astiotrema fukuii Ogata 1938a.—From *Trionyx sinensis* in Korea.

Astiotrema indica Thapar 1933a.—From *Chitra indica* in India.

Astiotrema loossii Mehra 1931c.—*A. gangeticus* Harshé 1932. From *Kachuga dhongoka* and *Lissemys punctata* in India.

Astiotrema monticellii Stossich 1904.—From *Natrix viperina* in Italy.

Astiotrema odhneri Bhalerao 1936b.—*A. "reniferum"* of Odhner 1910. From *Trionyx triunguis* in Africa.

Astiotrema orientale Yamaguti 1937a.—From *Trionyx japonica* in Japan.

Astiotrema rami Bhalerao 1936b.—From *Lissemys punctata* in India.

Astiotrema renifera (Looss 1898) Stossich 1904.—*Dist. reniferum* L. *Astia renifera* (L.) L. 1899, *D. reniforme* Lühe 1899; *D. unicum* Looss 1896 not *D. u.* Molin 1859. From *Trionyx triunguis* in Africa.

Genus BILORCHIS Mehra 1937

Bilorchis indicum Mehra 1937.—From *Lissemys punctata* in India.

Genus EUSTOMOS MacCallum 1921

Eustomos chelydrae MacCallum 1921.—From *Chelydra serpentina* and *Chrysemys picta* in the United States. Life history—Krull 1934, 1937.

Genus HAPLOMETROIDES Odhner 1910

Haplometroides buccicola Odhner 1910.—From *Elaps* sp. in Paraguay.

Genus MICRODERMA Mehra 1931d

Microderma elinguis Mehra 1931d.—From *Kachuga smithii* in India.

Microderma luehei (Travassos 1927c) Olsen 1937.—*Plagiorchis l.* T., *P. luhei* T. 1927d. From *Eunectes murinus* in Brazil.

Genus OPISTHIOGLYPHE Looss 1899

Opisthioglyphe adulescens Nicoll 1914a.—From *Viera aspis* in Europe.

Opisthioglyphe magnus Szidat 1932.—From *Causus rhombeatus* and *Thelotornis kirtlandii* in western Africa.

Ganus PLAGIORCHIS Lühe 1899

Plagiorchis mentulatus (Rudolphi 1819) Stossich 1904.—*Dist. mentulatum* R., *Lepoderma mentulatum* (R.) Looss 1899; *D. lacertae* R. 1819; *D. colubri natricis*

intestinale R. 1809; *D. c. tesselati* R. 1819. From frogs and from *Lacerta agilis, L. muralis, L. viridis, L. vivipara, Natrix natrix,* and *N. tesellata* in Europe.

Plagiorchis ramlianus (Looss 1896) Stossich 1904.—*Dist. ramlianum* L., *Lepoderma ramlianum* (L.) L. 1899. From a frog and from *Chamaeleo basiliscus* and *C. chamaeleon* in Egypt. Life history—Azim 1935.

Plagiorchis serpenticola Massino 1927 in Olsen 1937.—No information concerning this species or of the paper, M. 1927, is available to the writers.

Genus TREMIORCHIS Mehra and Negi 1926

Tremiorchis varanum Verma 1930.—From *Varanus bengalensis* and *V. griseus* in India.

Subfamily Undetermined

Genus LEUROSOMA Ozaki 1932

Leurosoma orientale Ozaki 1932.—From *Ocadia sinensis* in China.

Genus OISTOSOMUM Odhner 1902

Oistosomum caduceus Odhner 1902.—From a "Krokodil" in Sudan.

Genus PNEUMOTREMA Bhalerao 1937

Pneumotrema travassosi Bhalerao 1937.—From *Amphisbaena alba.*

Genus TRAVTREMA Pereira 1929a

Travtrema travtrema Pereira 1929a.—From *Liophis merremii* in Brazil.

Family RENIFERIDAE Baer 1924

Subfamily ENODIOTREMATINAE Baer 1924

Genus ENODIOTREMA Looss 1900

Enodiotrema acariaeum Looss 1902.—From *Caretta caretta* in Egypt.

Enodiotrema instar Looss 1901.—From *Caretta caretta* in Egypt.

Enodiotrema megachondrus (Looss 1899) Looss 1901.—*Enodia m.* L., *Enodiotrema megachondrum* (L.) Braun 1901; *Monost. caouanae* Kollar in Braun 1901. From *Caretta caretta, Chelonia mydas,* and *Testudo (gracca?)* in Egypt.

Enodiotrema reductum Looss 1901.—From *Caretta caretta* in Egypt.

Genus PACHYPSOLUS Looss 1901

Pachypsolus brachus Barker 1922.—From *Eretmochelys imbricata* near the Bermuda Islands.

Pachypsolus irroratus (Rudolphi 1819) Looss 1901.—*Dist. irrorata* R.; *P. lunatus* L. 1901. From *Caretta caretta* and *Chelonia mydas* near Europe and Africa and from a "sea tortoise" near Australia.

Pachypsolus ovalis Linton 1910.—From *Caretta caretta* near Florida.

Pachypsolus sclerops (Travassos 1922) Travassos 1929.—*Gastris s.* T. From *Caiman crocodilus* in Brazil.

Pachypsolus tertius Pratt 1914.—From *Caretta caretta* near Florida.

Subfamily RENIFERINAE Pratt 1902

Genus DASYMETRA Nicoll 1911

Dasymetra conferta Nicoll 1911.—From *Natrix rhombifera* and *N. sipedon* in North America.

Dasymetra longicirrus (Odlaug 1938) Byrd and Denton 1938b.—*Zeugorchis l.* O. From *Natrix sipedon* in Louisiana.

Dasymetra nicolli Holl and Allison 1935a.—From *Natrix sipedon* in Pennsylvania.

Dasymetra provitellaria Bennett 1938.—From *Farancia abacura* in Louisiana.

Dasymetra villicaeca Byrd 1935.—From *Natrix cyclopion, N. rhombifera,* and *N. sipedon* in Louisiana.

Genus LECHRIORCHIS Stafford 1905

Lechriorchis abduscens Byrd and Denton 1938b.—From *Lampropeltis getulus* in Louisiana.

Lechriorchis megasorchis (Crow 1913) Talbot 1934.—*Renifer m.* C. From *Natrix rhombifera* in the United States.

Lechriorchis plesientera Sumwalt 1926.—From *Thamnophis ordinoides* and *T. sirtalis* in Washington (State).

Lechriorchis primus Stafford 1905.—From *Thamnophis sauritus* and *T. sirtalis* in North America. Experimentally developed in *Natrix sipedon*—Talbot 1933.

Lechriorchis propria (Nicoll 1914a) Talbot 1934.—*Mediorima propria* N. From *Thamnophis ordinoides* in North America.

Lechriorchis tygarti Talbot 1933.—From *Thamnophis sauritus* and *T. sirtalis* in West Virginia.

Genus NEORENIFER Byrd and Denton 1938b

Neorenifer acetabularis (Crow 1913) Byrd and Deaton 1938b.—*Renifer a.* C. From *Natrix rhombifera* in the United States.

Neorenifer aniarum (Leidy 1891) Byrd and Denton 1938b.—*Dist. a.* L., *Renifer a.* (L.) Harwood 1932, *D. a.* (L.) H. 1932; *R. natricis* MacCallum 1921; *R. texanus* H. 1932. From *Heterodon contortrix, Natrix cyclopion, N. erythrogaster, N. rhombifera,* and *N. sipedon* in the United States.

Neorenifer drymarchon Byrd and Denton 1938b. From *Drymarchon corais* in Texas.

Neorenifer elongatus (Pratt 1903) Byrd and Denton 1938b.—*Renifer e.* P. From *Heterodon contortrix* in North America.

Neorenifer formosum (Nicoll 1911) Byrd and Denton 1938b.—*Ochetosoma f.* N., *Renifer f.* (N.) Talbot 1934. From *Leptodira annulata.*

Neorenifer georgianus Byrd and Denton 1938b.—From *Coluber constrictor* in Georgia.

Neorenifer glandularis Byrd and Denton 1938b. From *Sistrurus miliarius* in Florida.

Neorenifer heterodontis Byrd and Denton 1938b. From *Heterodon contortrix* in Mississippi.

Neorenifer kansensis (Crow 1913) Byrd and Denton 1938b.—*Renifer k.* C. From *Agkistrodon mokasen, A. piscivorus,* and *Sistrurus miliarius* in the United States.

Neorenifer orula (Talbot 1934) Byrd and Denton 1938b.—*Renifer o.* T. From *Natrix sipedon* in Michigan.

Neorenifer sauromates (Poirier 1885) Byrd and Denton 1938b.—*Dist. s.* P., *Plagiorchis s.* (P.) Stossich 1904, *Renifer s.* (P.) Talbot 1934. From *Elaphe quattuorlineata.*

Neorenifer septicus (MacCallum 1921) Byrd and Denton 1938b.—*Renifer s.* M.; *R. ophiboli* M. 1921. From *Lampropeltis getulus* in North America.

Neorenifer serpentis Schmidt and Hubbard 1940. From *Agkistrodon piscivorus* in Arkansas and (Crozier and Self 1941) *Heterodon contortrix* in Oklahoma.

Neorenifer validus (Nicoll 1911) Byrd and Denton 1938b.—*Lechriorchis v.* N.; *Renifer v.* (N.) Talbot 1934; *L. inermis* Lebour 1913, *R. i.* (L.) T. 1934. From *Coluber gemonensis* and *Heterodon contortrix.*

Neorenifer wardi (Byrd 1936a) Byrd and Denton 1938b.—*Renifer w.* B. From *Natrix rhombifera* in Mississippi.

Neorenifer zschokkei (Volz 1899) Byrd and Denton 1938b.—*Dist. z.* V., *Renifer z.* (V.) Pratt 1903. From *Heterodon contortrix.*

Genus NATRIODERA Mehra 1937

Natriodera verlatum (Talbot 1934) Mehra 1937.—*Macrodera v.* T. From *Natrix sipedon* in Michigan.

Genus PARALECHRIORCHIS Byrd and Denton 1938b

Paralechriorchis bosci (Cobbold 1859) Byrd and Denton 1938b.—*Dist. b.* C., *D. boscii* C. 1879, *Zeugorchis boscii* (C.) Odhner 1910, *Z. bosci* (C.) Price 1935; *Fasciola colubri* Bosc 1802, *D. c.* (B.) Rudolphi 1809; *D. c. americani* R. 1819. From "couleuvre d'Amérique."

Paralechriorchis syntomentera (Sumwalt 1926) Byrd and Denton 1938b.—*Zeugorchis s.* S., *Manodistonum s.* (S.) Harwood 1932, *Pseudorenifer s.* (S.) Allison and Holl 1937; *Z. syntometra* Price 1935 and *Pseudorenifer s.* (P.) P. 1935. From *Thamnophis ordinoides* and *T. sirtalis* in the United States.

Paralechriorchis natricis (Holl and Allison 1935b) Byrd and Denton 1938b.—*Zeugorchis n.* H. and A., *Pseudorenifer n.* (H. and A.) Price 1936d; *Lechriorchis secundus* Canavan 1937. From *Natrix sipedon* in Pennsylvania.

Genus PNEUMATOPHILUS Odhner 1910

Pneumatophilus foliaformis Talbot 1934. From *Natrix sipedon* in Michigan.

Pneumatophilus leidyi Byrd and Denton 1937. From *Natrix sipedon* in Georgia.

Pneumatophilus variabilis (Leidy 1856) Odhner 1910.—Dist. *variabile* L., *Renifer variabilis* (L.) Pratt 1903, *Styphlodora variabilis* (L.) de Faria 1911. From garter snakes and *Natrix sipedon* in North America.

Genus RENIFER Pratt 1902

Renifer ancistrodontis MacCallum 1921.—*Zeugorchis a.* (M.) Talbot 1934, *Pseudorenifer a.* (M.) Price 1935. From *Agkistrodon mokasen* in North America.

Renifer braachyoesophagidius (Allison and Holl 1937) Byrd and Denton 1938b. —*Pseudorenifer b.* A. and H. From *Thamnophis sirtalis* in New York.

Renifer ellipticus Pratt 1903.—From *Heterodon contortrix* in North America.

Renifer grandispinus Caballero 1938.—From *Drymarchon corais* in Mexico.

Renifer laterotrema Byrd and Denton 1938b.—From *Agkistrodon piscivorus* in Louisiana.

Renifer magnus Byrd and Denton 1938b.—From *Drymarchon corais* in Texas.

Renifer megametricus (Talbot 1934) Byrd and Denton 1938b.—*Zeugorchis m.* T., *Pseudorenifer m.* (T.) Price 1935. From *Thamnophis sirtalis* in Michigan.

Renifer n. sp. Job 1917. From *Coluber constrictor* in Iowa.

Genus ZEUGORCHIS Stafford 1905

Zeugorchis aequatus Stafford 1905.—*Manodistomum aequatum* (S). Harwood 1932. From *Thamnophis sirtalis* in North America.

Zeugorchis eurinus (Talbot 1933) Price 1936d.—*Caudorchis e.* T. From *Thamnophis sauritus* and *T. sirtalis* in Michigan.

Genus Undetermined

Cercaria ramonae McCoy 1928.—Metacercariae developed experimentally (M. 1928) in tadpoles and catfish: similar metacercariae found in same species in nature. Immature maritae experimentally produced in *Chelydra serpentina* and *Natrix sipedon;* similar worms found in *N. s.* in nature. In Missouri.

Subfamily STYPHLODORINAE Dollfus 1937
Genus ALLOPHARYNX Strom 1928

Allopharynx amudariensis (Strom 1928) Price 1938.—*Xenopharynx a.* S., *Ophiorchis a.* (S.) Mehra 1937. From *Natrix tessellata* in Turkestan.

Allopharynx mehrai (Gogate 1935) Price 1938.—*Ostiolum m.* G., *Ptyasorchis m.* (G.) Mehra 1937. From *Ptyas korros* and *P. mucosus* in Burma.

Allopharynx multispinosus (Bennett 1935) Price 1938.—*Megacustis m.* B. 1935, *M. m.* B. 1933 a nomen nudum. From *Anolis carolinensis* in Louisiana.

Allopharynx tropidonoti (MacCallum 1918) Price 1938.—*Dist. t.* M. From *Natrix trianguligera* in Java.

Genus APTORCHIS Nicoll 1914b

Aptorchis aequalis Nicoll 1914b.—From *Emydura australis* and *E. latisternum* in Australia. See N. 1918b.

Genus GLASSIDIELLA Travassos 1927a
(*Glossidiella* Travassos 1927d)

Glassidiella ornada Travassos 1927a.—*G. ornata* T. 1927b, *Glossidiella ornata* (T.) T. 1927d. From *Eunectes murinus* in Brazil.

Genus GLOSSIDIUM Looss 1899

Glossidium loossi (Travassos 1927a) Travassos 1927d.—*Glassidium l.* T. 1927a. From *Eunectes murinus* in South America.

Genus PTYASORCHIS Mehra 1937

Ptyasorchis mehrai (Gogate 1935) Mehra 1937.—*Ostiolum m.* G., *Allopharynx m.*

(G.) Price 1938. From *Ptyas korros* and *P. mucosus* in Burma. Recent study—Chatterji 1940.

Genus GLOSSIMETRA Mehra 1937

Glossimetra orientalis Mehra 1937.—From *Kachuga dhongoka* in India.

Genus SPINOMETRA Mehra 1928b.

Spinometra gangeticus Mehra 1937.—From *Kachuga dhongoka* in India.
Spinometra kachugae Mehra 1931a.—From *Kachuga dhongoka* in India.

Genus STYPHLODORA Looss 1899

Styphlodora agkistrodontis Byrd, Parker, and Reiber 1940b.—From *Agkistrodon piscivorus* in Florida.

Styphlodora aspina Byrd, Parker, and Reiber 1940b.—From *Agkistrodon piscivorus* in Florida.

Styphlodora bascaniensis Goldberger 1911b.—*Platymetra b.* (G.) Byrd, Parker, and Reiber 1940b. From *Coluber constrictor* in the United States.

Styphlodora compactum Byrd, Parker, and Reiber 1940b.—From *Coluber constrictor* in Florida.

Styphlodora condita de Faria 1911.—From *Spilotes pullatus* in Brazil.

Styphlodora dentipharyngeata Chatterji 1940.—From *Ptyas korros* in Burma.

Styphlodora floridanis Byrd, Parker, and Rieber 1940b.—From *Agkistrodon piscivorus* in Florida.

Styphlodora horrida (Leidy 1850) Odhner 1910.—*Dist. horridum* L., *Plagiorchis horridus* (L.) Stossich 1904.—From *Constrictor constrictor* and *Python molurus* in America and India.

Styphlodora lachesidis MacCallum 1921.—From *Trimeresurus atrox* in Trinidad and *Ptyas mucosus* in Indo-China.

Styphlodora magna Byrd and Denton 1938a.—From *Natrix sipedon* in the United States.

Styphlodora najae Nicoll 1912b—From *Naja naja* in India.

Styphlodora natricis Byrd and Denton 1938a.—From *Natrix sipedon* in the United States.

Styphlodora nicolli Bhalerao 1936b.—From *Ptyas mucosus* in India.

Styphlodora persimilis Nicoll 1914a.—From *Natrix piscator* in India.

Styphlodora renalis Tubangui 1933.—From *Python reticulatus* in the Philippine Islands.

Styphlodora serrata Looss 1899.—From *Varanus niloticus* in Egypt.

Styphlodora similis (Sonsino 1890) Odhner 1910.—*Dist. simile* S. From *Python molurus* in Africa.

Subfamily STYPHLOTREMATINAE Baer 1924
Genus STYPHLOTREMA Odhner 1910

Styphlotrema solitaria (Looss 1899) Odhner 1910.—*Styphlodora solitaria* L., *Renifer solitarius* (L.) Pratt 1903. From *Caretta caretta* near Egypt and Florida.

Subfamily TELORCHIINAE Looss 1899
(*Telorchinae* Stunkard 1924)
Genus AURIDISTOMUM Stafford 1905

Auridistomum chelydrae (Stafford 1900) Stafford 1905.—Synonyms from Wharton 1940: *Dist. c.* S., *Rhytidodes c.* (S.) MacCallum 1921; *Pterygomaschalos attenuatus* Stunkard 1924; *Cercaria concavocorpa* Sizemore 1936a, *Tetrapapillatrema c.* (S.) Ralph 1938. From *Chelydra serpentina* in North America.

Genus CERCOLECITHOS Perkins 1928

Cercolecithos molini nobis.—*Dist.* "*arrectum*" of Molin 1859, *Telorchis arrectus*—Stossich 1904, *C. arrectus*—Perkins 1928. From *Lacerta muralis* in Italy.

Genus PROTENES Barker and Covey 1911

Protenes angustus (Stafford 1900) Ward 1918.—Synonyms from Wharton 1940: *Dist. angustum* S., *Telorchis angustus* (S.) S. 1905; *T. leptus* Barker and Covey 1911, *P. l.* (B. and C.) Stunkard 1915; *P. chapmani* Harwood 1932; *P. vitellosus* Bennett 1935, *P. vitllosus* [sic] B. 1933—nomen nudum. From *Chrysemys picta* and *Pseudemys scripta* in North America.

Genus TELORCHIS Lühe 1899
(Not *Telorchis* Looss 1899)

Telorchis aculeatus (von Linstow 1879) Braun 1901.—*Monost. aculeatum* L.: *Dist. linstowii* Stossich 1890, *T. l.* (S.) Looss 1899, *D. linstowi* Monticelli 1893, *Cercorchis l.* (M.) Perkins 1928. From *Testudo graeca* in Europe.

Telorchis attenuatus Goldberger 1911a.—*Cercorchis a.* (G.) Perkins 1928. From *Chrysemys picta* in North America.

Telorchis auridistomi (Byrd 1937b) Wharton 1940.—*Cercorchis a.* B. From *Farancia abacura* in Louisiana.

Telorchis bifurcus (Braun 1899) Braun 1901.—*Dist. bifurcum* B., *Cercorchis bifurcus* (B.) Perkins 1928. From *Podocnemis expansa* in Brazil.

Telorchis clavus (Diesing 1850) Perkins 1928.—*Dist. clava* D., *T. clava* (D.) Lühe 1899; *Plagiorchis anacondae* MacCallum 1921, *T. a.* (M.) P. 1928. From *Cloelia cloelia, Coluber constrictor, Eunectes murinus,* and *Oxyropus fasciatus* in South America.

Telorchis clemmydis Yamaguti 1933.—*Cercorchis c.* (Y.) Wharton 1940; *Paracercorchis megacotyle* Fukui and Ogata 1933. From *Chinemys reevesi* and *Clemmys japonica* in Japan.

Telorchis corti Stunkard 1915.—Synonyms from Wharton 1940: *Cercorchis c.* (S.) Perkins 1928; *T. "linstowi"* of Goldberger 1911a; *T. lobosus* S. 1915, *C. l.* (S.) P. 1928; *T. insculpti* MacCallum 1918, *C. i.* (M.) P. 1928; *T. guttati* M. 1918, *C. g.* (M.) P. 1928; *T. chelopi* M. 1918, *C. c.* (M.) P. 1928; *T. pallidus* M. 1918, *C. p.* (M.) P. 1928; *T. "angustus"* of M. 1921; *T. stenonura* Ingles 1930, *C. s.* (I.) Byrd 1936b; *C. texanus* Harwood 1932; *C. "medius"* of McMullen 1934. From *Chelydra serpentina, C. picta, Clemmys guttata, C. insculpta, C. marmorata, Deirochelys reticularia, Graptemys geographica, Malaclemys pileata,* and *Pseudemys scripta* in North America.

Telorchis cyclemidis (Tubangui 1933) Wharton 1940.—*Cercorchis c.* T. From *Cuora amboinensis* in the Philippine Islands.

Telorchis dhongokii (Mehra and Bokhari 1932) Wharton 1940.—*Cercorchis d.* M. and B. From *Kachuga dhongoka* in India.

Telorchis diminutus Stunkard 1915.—*Cercorchis d.* (S.) Wharton 1940; *C. kinosterni* Byrd 1936b. From *Kinosternon steindachneri* and *K. subrubrum* in North America.

Telorchis dissimilis (Caballero 1938) nobis.—*Cercorchis d.* C. From *Pseudemys scripta* in Mexico.

Telorchis ercolanii (Monticelli 1893) Braun 1901.—*Dist. e.* M., *Cercorchis e.* (M.) Perkins 1928; *D. "mentulatum"* and *D. "signatum"* of Ercolani 1881; *T. s.*—Lühe 1899; *D. nematoides* Mühling 1898, *T. n.* (M.) B. 1901, *C. n.* (M.) L. 1909. From *Natrix natrix, N. tessellata,* and *N. viperina* in Europe, Asia Minor, and northern Africa.

Telorchis gabesensis Ruszkowski 1926.—*T. ruszkowski* Yamaguti 1933. From *Clemmys leprosa* in Africa.

Telorchis geoclemmydis Yamaguti 1933.—*Cercorchis g.* (Y.) Wharton 1940. From *Chinemys reevesi* in Japan.

Telorchis hagmanni Lent and de Freitas 1937. From *Podocnemis expansa* in Brazil.

Telorchis konoi Ogata 1934a.—*Cercorchis k.* (O.) Wharton 1940. From *Chinemys reevesi* in Japan.

Telorchis medius Stunkard 1915.—*Cercorchis m.* (S.) Perkins 1928; *C. bairdi* Harwood 1932. From *Kinosternon steindachneri, K. subrubrum, Pseudemys scripta, Sternotherus carinatus, S. odoratus,* and *Terrapene carolina* in North America.

Telorchis parvus Braun 1901.—*Cercorchis p.* (B.) Lühe 1909, *Paratelorchis parms* [sic] Mehra and Bokhari 1932. Without any mention of *Paratelorchis* M. and B. this species was listed as *T. p.* by Wharton 1940. From *Emys orbicularis* in Europe, Asia Minor, and northern Africa.

Telorchis pellucidus (Mehra and Bokhari 1932) Wharton 1940.—*Paracercorchis p.* M. and B. From Kachuga dhongoka in India.

Telorchis pleroticus (Braun 1899) Braun 1901.—*Dist. pleroticum* B., *Cercorchis pleroticus* (B.) Perkins 1928. From a "testuggini d'acqua dolce" in Brazil.

Telorchis poirieri (Stossich 1895) Odhner 1902.—*Dist. p.* S., *Cercorchis p.* (S.) Lühe 1909; *D. "gelatinosum"* of Poirier 1885. From *Emys orbicularis* in Europe, Asia Minor, and northern Africa.

Telorchis pseudoaculeatus Dollfus 1929c.—*T. "aculeatus"* of Stunkard 1915. From *Natrix grahamii* in North America.

Telorchis robustus Goldberger 1911a.—*Cercorchis r.* (G.) Perkins 1928. From *Pseudemys scripta, Sternotherus odoratus,* and *Terrapene carolina* in North America.

Telorchis singularis (Bennett 1935) Wharton 1940.—*Cercorchis s.* B. 1935, *C. s.* B. 1933—nomen nudum; *T. "robustus"* of Stunkard 1915. From *Chelydra serpentina* and *Pseudemys scripta* in North America.

Telorchis solivagus Odhner 1902.—*Cercorchis s.* (O.) Perkins 1928; *C. shelkownikowi* Skrjabin and Popoff 1924. From *Clemmys caspica* and *Emys orbicularis* in Europe and Asia Minor.

Telorchis solivague macroccanus Dollfus 1929c.—From *Clemmys leprosa* in Morocco.

Telorchis stossichi Goldberger 1911a.—*Cercorchis s.* (G.) Perkins 1928; *T. "poirieri"* of Stossich 1904. From *Emys orbicularis* in Europe.

Telorchis sp. (Heymann 1905) nobis.—*Dist.* sp. H., *Cercorchis* sp. (H.) Perkins 1928. From *Dermatemys mawii.*

Subfamily Undetermined

Genus DOLICHOPERA Nicoll 1914b

Dolichopera macalpini Nicoll 1914b.—From *Denisonia superba* and *Notechis scutatus* in Australia. See N. 1918a.

Dolichopera parvula Nicoll 1914b.—From *Morelia argus* in Australia.

Genus HETEROCOELIUM Travassos 1921a

Heterocoelium heterocoelium Travassos 1921a. From *Trimeresurus neuwiedii* in Brazil.

Genus OCHETOSOMA Braun 1901

Ochetosoma monstruosum Braun 1901. From *Erythrolamprus venustissimus* in the West Indies.

Genus STOMATREMA Guberlet 1928

Stomatrema guberleti Byrd 1937b. From *Farancia abacura* in Louisiana.
Stomatrema pusilla Guberlet 1928. From *Farancia abacura* in Florida and Texas.

Genus XENOPHARYNX Nicoll 1912b

Xenopharynx piscator Bhalerao 1926. From *Natrix piscator* in India.
Xenopharynx solus Nicoll 1912b. From *Naja hannah* and *N. naja* in India.

Family RHYTIDODIDAE Odhner 1926

Genus RHYTIDODES Looss 1901

Rhytidodes gelatinosus (Rudolphi 1819) Looss 1901.—*Dist. gelatinosum* R. From

Caretta caretta and *Chelonia mydas* near Egypt and from a "sea tortoise" near Australia.

Rhytidodes secundus Pratt 1914.—From *Caretta caretta* in the Gulf of Mexico.

Genus RHYTIDODOIDES Price 1939a

Rhytidodoides intestinalis Price 1939a.—From *Chelonia mydas* near the United States.

Rhytidodoides similis Price 1939a.—From *Chelonia mydas* near the United States.

Unclassified Fasciolata
Genus PATAGIUM Heymann 1905

Patagium brachydelphium Heymann 1905.—From *Dermatemys mawii.*

Patagium lazarevi Skrjabin and Popoff 1924.—From *Emys orbicularis* in Armenia.

Species of Undetermined Generic Status

Agamodistomum anguis (von Linstow 1885) Stossich 1895.—*Dist. a.* L. From *Anguis fragilis.*

Agamodistomum viperae (von Linstow 1887) Stossich 1895.—*Dist. v.* L. From *Vipera berus.*

Cercaria nigrocystica Bradley 1926.—From "blacksnakes" in Australia.

Dist. acervocalciferum Gastaldi 1854.—From frogs and *Natrix natrix* in Europe.

Dist. apolaimum Heymann 1905.—From *Kachuga tectum.*

Dist. armatissimum von Linstow 1903.—From *Iguana* sp.

Dist. cloacicola Lühe 1909.—From *Natrix natrix* in Europe.

Dist. gracillimum Lühe 1909.—From *Natrix natrix* in Europe.

Dist. incerta Cobbold 1885.—From *Coluber* in Rio Plata.

Dist. megaloon von Linstow 1879.—From *Lacerta agilis* in Europe.

Dist. nardoi Polonio 1895.—From *Lacerta muralis* in Italy.

Dist. pachyderma Braun 1899.—*D. cheloniae atrae* B. 1899. From *Caretta caretta.*

Dist. pyxidatum Bremser in Rudolphi 1819.—From *Caiman crocodilus* in Brazil.

Dist. simplex Polonio 1859.—From *Lacerta muralis* in Italy.

Dist. sp. Sonsino 1890.—From *Python molurus.*

Dist. testudinis Rudolphi 1819.—*Monost. delicatulum* Diesing 1850. From *Caretta caretta* and *Emys orbicularis.*

Dist. testudinis mydae Rudolphi 1809.—*D. intestinalis t. m.* Viborg in R. 1809.

Monost. pseudamphistomum Creplin 1846.—From *Chelonia mydas.*

Monost. macrorchis Brandes 1892.—From marine turtles.

Monost. sp. Braun 1901.—From *Chelonia mydas.*

Order SANGUINICOLATA Nicoll 1939a
Superfamily SANGUINICOLOIDEA Nicoll 1935
Family SPIRORCHIIDAE MacCallum 1921
(*Spirorchidae* Stunkard 1921)
Subfamily SPIRORCHIINAE MacCallum 1921
(*Spirorchinae* Stunkard 1921)
Genus AMPHIORCHIS Price 1934

Amphiorchis amphiorchis Price 1934.—From *Chelonia mydas* in North America.

Amphiorchis lateralis Oguro 1938.—From *Eretmochelys imbricata* in Japan.

Genus HAPALORHYNCHUS Stunkard 1922

Hapalorhynchus evaginatus Byrd 1939.—From *Trionyx spinifera* in Tennessee.

Hapalorhynchus gracilis Stunkard 1922.—From *Chelydra serpentina* in North America.

Hapalorhynchus indicus (Thapar 1933b) Price 1934.—*Tremarhynchus i.* T., *Coeuritrema i.* (T.) Mehra 1934, *Rhynchotrema indica* (T.) T. 1933b. From *Trionyx gangetica* in India.

Hapalorhynchus lyssimus (Mehra 1933) nobis.—*Coeuritrema l.* M.; *H. lyssemus* Byrd 1939. From *Lyssemys punctata* in India.

Hapalorhynchus odhnerensis (Mehra 1933) Byrd 1939.—*Coeuritrema o.* M. From *Lyssemys punctata* in India.

Hapalorhynchus reelfooti Byrd 1939.—From *Sternotherus odoratus* in Tennessee.

Hapalorhynchus sp. Ozaki 1932.—From *Ocadia sinensis* in China.

Hapalorhynchus stunkardi Byrd 1939.—From *Sternotherus carinatus* in Tennessee.

Hapalorhynchus yoshidai Ozaki 1939.—From *Ocadia sinensis.*

Genus HAPALOTREMA Looss 1899

Hapalotrema loossi Price 1934.—*Dist.* "*constrictum* Leared" and *H.* "*c. . . .*" of Looss 1899. From *Caretta caretta* in Egypt.

Hapalotrema mistroides (Monticelli 1896) Stiles and Hassall 1908.—[*Dist.* and *Mesogonimus*]—M., *D. m.* (M.) Braun 1899, *M. m.* (M.) Byrd 1939; *D.* "*constrictum* Leared" and *M.* "*constrictus*" of M. 1896. From *Caretta caretta.*

Hapalotrema polesianum (Ejamont 1927) Byrd 1939.—*Spirhapalum p.* E. From *Emys orbicularis* in Poland.

Hapalotrema synorchis Luhman 1935.—From *Caretta caretta* in Florida.

Genus LEAREDIUS Price 1934

Learedius europaeus Price 1934.—*Dist. constrictum* Leared 1862 not *D. c.* Mehlis 1846. From "common turtle" and "edible turtle" in Europe and (Gohar 1934) from *Caretta caretta* and *Chelonia mydas* in Egypt.

Learedius learedi Price 1934.—From *Chelonia mydas* in the United States.

Learedius similis Price 1934.—From *Chelonia mydas* in the United States.

Genus NEOSPIRORCHIS Price 1934

Neospirorchis schistosomatoides Price 1934.—From *Chelonia mydas* in the United States.

Genus SPIRORCHIS MacCallum 1918

Spirorchis artericola (Ward 1921) Stunkard 1923.—*Proparorchis a.* W. From *Chrysemys picta, Graptemys geographica, G. pseudogeographica, Pseudemys floridana,* and *P. scripta* in the United States.

Spirorchis blandingi MacCallum 1926.—*Diarmostorchis* b. (M.) Esjmont 1927. From *Emys blandingii* in North America.

Spirorchis blandingioides Byrd 1939.—From *Pseudemys floridana* and *P. scripta* in Tennessee.

Spirorchis elegans Stunkard 1923.—*S. picta* S. 1923. From *Chrysemys picta* and *Pseudemys scripta* in North America.

Spirochis elephantis (Cort 1917) Wall 1941a.—*Cercaria e.* C. Cercariae from snails; adults from *Chrysemys picta* in Michigan.

Spirorchis haematobium (Stunkard 1922) Price 1934.—*Henotosoma h.* S.; *S. chelydrae* MacCallum 1926; *H. c.* (M.) Harwood 1932. From *Chelydra serpentina* in the United States.

Spirorchis hardellii (Mehra 1934) Byrd 1939.—*Plasmiorchis h.* M.; *P. obscurum* M. 1934. From *Hardella thurgi* and *Kachuga dhongoka* in India.

Spirorchis innominata Ward 1921.—*S. emydis MacCallum* 1921; *S. eustreptos* M. 1921; *S. pictae* M. 1926. From *Chrysemys picta, Clemmys insculpta, Emys blandingii,* and *Pseudemys floridana* in North America.

Spirorchis magnitestis Byrd 1939.—From *Chelydra serpentina* in Tennessee.

Spirorchis minutum Byrd 1939.—From *Chelydra serpentina* in Tennessee.

Spirorchis orientalis (Mehra 1934) Byrd 1939.—*Plasmiorchis o.* M.; *P. pellucidus* Mehra 1934, *S. p.* (M.) B. 1939. From *Kachuga dhongoka* in India.

Spirorchis parvum (Stunkard 1923) Price 1934.—*Haematotrema p.* S. From *Chelonia mydas* in the United States. Life history—Wall 1939, 1940, and 1941b.

Spirorchis pseudemyae Byrd 1939.—From *Pseudemys scripta* in Tennessee.

Spirorchis sanguina (Sinha 1934b) Byrd 1939.—*Comtiotrema s.* S. From *Hardella thurgi* in India.

Spirorchis scripta Stunkard 1923.—From *Graptemys pseudogeographica*, *Pseudemys floridana*, and *P. scripta* in North America.

Genus UNICAECUM Stunkard 1925b.

Unicaecum dissimilis Byrd 1939.—From *Pseudemys scripta* in Tennessee.

Unicaecum ruszkowskii Stunkard 1925b.—From *Pseudemys scripta* in North America.

Genus VASOTREMA Stunkard 1928
(*Vasatrema* Stunkard 1926)

Vasotrema amydae (Stunkard 1926) Stunkard 1928.—*Vasatrema a.* S. From *Trionyx ferox* and *T. spinifera* in North America.

Vasotrema attenuatum Stunkard 1928.—From *Trionyx ferox* and *T. spinifera* in North America.

Vasotrema longitestis Byrd 1939.—From *Trionyx spinifera* in Tennessee.

Vasotrema robustum Stunkard 1928.—From *Trionyx ferox* and *T. spinifera* in North America.

Order STRIGEATA La Rue 1926b
Superfamily CYATHOCOTYLOIDEA Nicoll 1937
Family CYATHOCOTYLIDAE Poche 1926
Subfamily CYATHOCOTLINAE Mühling 1896
Genus CYATHOCOTYLE Mühling 1896

Cyathocotyle fraterna Odhner 1902.—From *Crocodylus niloticus* in Egypt.

Subfamily PROHEMISTOMATINAE nobis
(*Prohemistominae* Lutz 1935)
Genus MESOSTEPHANUS Lutz 1935

Mesostephanus burmanicus Chatterji 1940.—From *Enhydris enhydris* in Burma.

Subfamily SZIDATINAE Dubois 1938b
Genus GOGATEA Lutz 1935a

Gogatea serpentum (Gogate 1932) nobis.—*Prohemistomum s.* G., *P. serpentium* Lutz 1935a, *G. serpentium* (L.) Szidat 1936. From *Natrix piscator* in India.

Genus SZIDATIA Dubois 1938b

Szidatia joyeuxi (Hughes 1929b) Dubois 1938b.—*Diplostomum* sp. Joyeux 1923b. *Diplostomulum j.* H., *Diplostomum j.* (H.) Solomon 1935?, *Prohemistomum j.* (H.) J. and Baer 1934; probably *Cercaria vivax* Sonsino 1892 in part. Adults from *Natrix natrix* and *N. viperina* in Tunisia; metacercariae in fish and frogs—J. and B. 1934.

Superfamily DIPLOSTOMATOIDEA Nicoll 1937
Family DIPLOSTOMATIDAE nobis
(*Diplostomidae* Poirier 1886)
Subfamily ALARIINAE Hall and Wigdor 1918c
Genus ALARIA Schrank 1788

Alaria intermedia (Olivier and Odlaug 1938) Odlaug 1940.—*Mesocercaria i.* O and O., *Cercaria A. i.* (O. and O). Odlaug 1940. Parthenitae from snails, mesocercariae from frogs and *Thamnophis sirtalis*, metacercariae from rodents, adults from carnivores; in Michigan.

Genus PHARYNGOSTOMUM Ciurea 1922

Pharyngostomum congolense Berghe 1939.—From a toad, a mammal, and *Kinixys belliana* in Belgian Congo.

Pharyngostomum cordatum (Diesing 1850) Ciurea 1922.—*Hemistomum c.* D., *Hemistoma c.* (D.) Cobbold 1860, *Alaria cordata* (D.) Railliet 1919, *Hemistomum kordatum* Schneidemühl 1898; *Holostomum linguaeformis* Dubois 1938b; *Diplostomulum mutadomum* Wallace 1937; perhaps (Wallace 1939) *Diplostomum putorii* von Linstow 1877, *Tetracotyle p.* (L.) Mataré 1910, and *Diplostomulum p.* (L.) Hughes 1929b. Adults from cats in Europe and Asia. Parthenitae in snails; metacercariae in

various amphibians and *Elaphe radiata*, *Enhydris chinensis*, *Eumeces chinensis*, *Natrix piscator*, and *N. stolata*. Life history—Wallace 1939.

Family PROTERODIPLOSTOMATIDAE nobis
(*Proterodiplostomidae* Dubois 1936)
Subfamily OPHIODIPLOSTOMATINAE nobis
(*Ophiodiplostominae* Dubois 1936)
Genus HETERODIPLOSTOMUM Dubois 1936

Heterodiplostomum lanceolatum Dubois 1936.—From *Coluber* sp. in Brazil.

Genus OPHIODIPLOSTOMUM Dubois 1936

Ophiodiplostomum spectabile Dubois 1936.—From *Drymobius bifossatus* and *Coluber* spp. in Brazil.

Genus PETALODIPLOSTOMUM Dubois 1936

Petalodiplostoumum ancyloides Dubois 1936.—From *Coluber* sp. in Brazil.

Genus PROALARIOIDES Yamaguti 1933

Proalarioides serpentis Yamaguti 1933.—From *Elaphe climacopohra* and *E. quadrivirgata* in Japan.

Subfmily POLYCOTYLINAE Monticelli 1888
Genus CROCODILICOLA Poche 1926

Crocodilicola gavialis (Narain 1930) Vidyarthi 1937.—*Neodiplostomum g.* N. From *Gavialis gangeticus* in India.

Crocodilicola pseudostoma (Willemoes-Suhm 1870) Poche 1926.—*Dist. p.* W.-S., *Diplostomum pseudostomum* (W.-S.) Poirier 1886; *Neodiplostomum poirieri* Dubois 1932. From *Alligator mississipiensis* and "*Crocodilus* sp." in North and South America.

Genus CYSTODIPLOSTOMUM Dubois 1936

Cystodiplostomum hollyi Dubois 1936.—From *Caiman crocodilus* and *C. latirostris* in Brazil.

Genus HERPETODIPLOSTOMUM Dubois 1936

Herpetodiplostomum caimancola (Dollfus 1935) Dubois 1936.—*Crocodilicola c. Dollfus.* From *Caiman crocodilus*, *C. latirostris*, and *Melanosuchus niger* in Brazil.

Herpetodiplostomum testudinis Dubois 1936.—From *Testudo* sp. in Brazil.

Genus PARADIPLOSTOMUM La Rue 1926a

Paradiplostomum abbreviatum (Brandes 1888) La Rue 1926b.—*Diplostomum a.* B., *Paradiplostoma a.* (B.) Dollfus 1935, *Crocodilicola abbreviatus* (B.) Poche 1926. From *Caiman crocodilus* and "*Crocodilus*" sp. in Brazil.

Genus POLYCOTYLE Willemoes-Suhm 1870

Polycotyle ornata Willemoes-Suhm 1870.—From *Alligator mississipiensis* in South Carolina.

Genus PROLECITHODIPLOSTOMUM Dubois 1936

Prolecithodiplostomum cavum Dubois 1936.—From *Caiman crocodilus* in Brazil.

Prolecithodiplostomum constrictum Dubois 1936.—From *Caiman crocodilus* in Brazil.

Subfamily PROTERODIPLOSTOMATINAE nobis
(*Proterodiplostominae* Dubois 1936)
Genus MESODIPLOSTOMUM Dubois 1936

Mesodiplostomum gladiolum Dubois 1936.—From *Melanosuchus niger* in Brazil.

Genus PROTERODIPLOSTOMUM Dubois 1936

Proterodiplostomum longum (Brandes 1888) Dubois 1936.—*Diplostomum l.* B., *Neodiplostomum l.* (B.) D. 1932, *Crocodilicola longus* (B.) Poche 1926. From "*Crocodilus coroa*," "*Crocodilus*" sp. and *Melanosuchus niger* in Brazil.

Proterodiplostomum tumidulum Dubois 1936.—From *Caiman crocodilus* in Brazil.

Genus PSEUDONEODIPLOSTOMUM Dubois 1936

Pseudoneodiplostomum siamense (Poirier 1886) Dubois 1936.—*Diplostomum s.* P., *Neodiplostomum s.* (P.) Poche 1926. *Crocodilicola siamensis* (P.) D. 1932. From *Crocodylus siamensis* in Asia.

Pseudoneodiplostomum thomasi (Dollfus 1935) Dubois 1936.—*Neodiplostoma t.* D., *Neodiplostomum t.* (D.) Dubois 1938b. From *Osteolaemus tetraspis* in Africa.

Genus TRAVASSOSTOMUM Bhalerao 1938

Travassostomum natritis Bhalerao 1938.—From *Natrix piscator* in India.

Superfamily STRIGEOIDEA Railliet 1919
Family STRIGEIDAE Railliet 1919
Subfamily STRIGEINAE Railliet 1919
Genus STRIGEA Abildgaard 1790

Strigea strigis (Schrank 1788) Abildgaard 1790.—Synonyms from Dubois 1938b: *Festucaria s.* S., *Fasciola s.* (S.) Gmelin 1790, *Planaria s.* (S.) Zeder 1803, *S. s. oti* Viborg 1795; *P. teres poro simplici* Göze 1782, in part; *S. ululae* V. 1795; *Fe. otidis* Frölich 1802; *Amphist. clavigerum* Z. 1803; *A. macrocephalum* Rudolphi 1803, *Holostoma m.* (R.) de Blainville 1828, *Holostomum m.* (R.) Creplin 1839; *Holostomum variabile* Nitzsch 1819, *Holostoma v.* (N.) Stiles and Hassall 1894, *Monost. v.* (N.) Davaine 1860, *Holostomum variabilis* Scheuring and Eversbusch 1926; *Holostomum cornucopia* Molin 1859, *Holostomum cornucopiae* Diesing 1859, *Strigea cornucopiae* (D.) Faust 1918; *Holostomum excisum* von Linstow 1906; *Tetracotyle colubri* L. 1877; *T. s.* (S.) Hughes 1929a. Adults from various hawks and owls in Europe; metacercariae from *Natrix natrix* and *Vipera berus.*

Strigea vaginata (Brandes 1888) Szidat 1928.—Synonyms mostly from Dubois 1938b: *Holostomum vaginatum* B., *Gongylura vaginata* (B.) Lutz 1933a; *Tetracotyle ophiocystis* L. 1928, *S. o.* (L.) L. 1928; *S. theriocystis* L. 1928; *Holostoma microcephalum* Brandes in Dubois 1938b; *Cercaria Strigeae vaginatae* (B.) D. 1938b; *Dicranocercaria gyrinipeta* L. 1934a; *Mesocercaria Strigeae vaginatae* (B.) D. 1938b; "pseudodistomulos com 8 cellule glandulares" of L. 1933a; [*T.*] *ichthyocystis* L. 1929a. Adults from birds; cercariae from snails; mesocercariae from frogs; metacercariae from fish, mammals, and different species of snakes—in Brazil.

Unclassified Strigeoidea

The species listed here are strigeoids of problematical affinities. Those of the first group, listed under their original names, have been regarded as forms never adequately described. The second group comprises larvae whose respective relationships to adult maritae are unknown.

Adults

Diplostomum brevis MacCallum 1921.—*Crocodilicola b.* (M.) Dubois 1935. From *Kinosternon scorpioides* on Trinidad Island.

Diplostomum cinosterni MacCallum 1921.—*Crocodilicola c.* (M.) Dubois 1935. From *Kinosternon scorpioides* on Trinidad Island.

"Diplostome" *medusae* Dubois 1937.—From *Caiman crocodilus* in Brazil.

Dist. bifurcatum Wedl 1861.—*Diplostomum b.* (W.) Brandes 1888, *Neodiplostomum b.* (W.) Dubois 1932, *Diplostoma b.* (W.) Dollfus 1935, *Crocodilicola bifurcatus* (W.) Poche 1926. From *Crocodylus niloticus* in Egypt.

Neodiplostomum crocodilarum Tubangui and Masilungan 1936.—From *Crocodylus porosus* in Philippine Islands.

Neodiplostoma sp. Dollfus 1935.—From *Crocodylus cataphractus* in Africa.

Proalarioides tropidonotis Vidyarthi 1937.—*P. tropidonoti* Nicoll 1939. From *Natrix piscator* in India.

Larvae

Agamodistomum marcianae (La Rue 1917) Cort 1918.—*Cercaria m.* L. R., *Meso-*

cercaria m. (L. R.) Olivier and Odlaug 1938. Mesocercaria from frogs and *Thamnophis marcianus* and *T. sirtalis* in North America.

Agamodistomum ordinata (Nicoll 1912a) Hughes 1928.—*Cercaria o.* N. From *Thamnophis sirtalis*—American snakes that died in London.

Agamodistomum sp. Sumwalt 1926.—From *Thamnophis sirtalis* and *T. ordinoides* in Washington (State).

Diplostomulum sirtale (Nicoll 1912a) Wallace 1937.—*Diplostomum s.* N., *Diplostomulum sirtali* Hughes 1929b. From *Thamnophis sirtalis*—American snakes that died in London.

Diplostomulum vegrandis (La Rue 1917) Hughes 1929b.—*Cercaria v.* L. R. From *Thamnophis eques, T. marcianus, T. sauritus,* and *T. sirtalis* in North America.

Tetracotyle serpentis Hughes 1929a.—From *Natrix sipedon* and *Thamnophis sirtalis* in Michigan.

Tetracotyle crystallina (Rudolphi 1819) von Linstow 1877.—*Dist. crystallinum* R. From various amphibians and *Vipera berus* in Europe.

Tetracotyle tiliquae Nicoll 1914b.—From *Tiliqua scincoides* in Australia.

Subclass MONOGENEA Carus 1863
Order POLYSTOMATIDEA Nicoll 1939b
Suborder POLYOPISTHOCOTYLEA Odhner 1912
Superfamily POLYSTOMATOIDEA Price 1936a
Family POLYSTOMATIDAE Gamble 1896
(*Polystomidae* Braun 1890)
Subfamily POLYSTOMATINAE Gamble 1896
(*Polystominae* Pratt 1900)
Genus NEOPOLYSTOMA Price 1939b

Neopolystoma chelodinae (MacCallum 1919) Price 1939b.—*Polystoma c.* M. From *Chelodina longicollis* in New York Zoological Park.

Neopolystoma domitilae (Caballero 1938) Price 1939b.—*Polystoma d.* C. From *Pseudemys scripta* in Mexico.

Neopolystoma exhamatum (Ozaki 1935) Price 1939b.—*Polystomoides e.* O. From *Clemmys japonica* in Japan.

Neopolystoma orbiculare (Stunkard 1916) Price 1939b.—*Polystoma o.* S., *Polystomoides o.* (S). Ozaki 1935; *Polystoma "oblongum"* of Leidy 1888; *Polystoma troosti* MacCallum 1919; *Polystoma inerme* M. 1919; *Polystoma elegans* M. 1919; *Polystoma spinulosum* M. 1919; *Polystoma aspidonectis* M. 1919; *Polystoma floridanum* S. 1924. From *Chrysemys pica, Malaclemys centrata, Pseudemys rubriventris, P. scripta, Trionyx ferox,* and "terrapin" from the United States.

Neopolystoma rugosa (MacCallum 1919) Price 1939b.—*Polystoma r.* M. From *Trionyx ferox* in the United States.

Neopolystoma terrapenis (Harwood 1932) Price 1939b.—*Polystoma t.* H. From *Terrapene carolina* in Texas.

Genus POLYSTOMOIDELLA Price 1939b

Polystomoidella oblongum (Wright 1879) Price 1939b.—*Polystoma o.* W.; *Polystoma hassalli* Goto 1899. From *Chelydra serpentina,* (?) *Chrysemys picta, Kinosternon hirtipes, K. subrubrum, Sternotherus carinatus,* and *S. odoratus* in North America.

Polystomoidella whartoni Price 1939b.—From *Kinosternon baurii, K. hirtipes, K. steindachneri,* and *K. subrubrum* in North America.

Genus POLYSTOMOIDES Ward 1917

Polystomoides coronatum (Leidy 1888) Ozaki 1935.—Synonyms from Price 1939: *Polystoma c.* L.; *Polystoma opacum* Stunkard 1916; *Polystoma megacotyle* S. 1916; *Polystoma microcotyle* S. 1916; *Polystoma albicollis* MacCallum 1919; *Polystoma digitatum* M. 1919. From *Chelydra serpentina, Chrysemys picta, Graptemys geographica,*

Pseudemys scripta, *Trionyx ferox*, *T. spinifera*, "spotted turtle," and "terrapin" in North America.

Polystomoides japonicum Ozaki 1935.—From *Clemmys japonica* in Japan.

Polystomoides kachugae (Stewart 1914) Ozaki 1935.—*Polystoma k.* S. From *Kachuga kachuga* in India.

Polystomoides megaovum Ozaki 1936.—From *Geoemyda spengleri* in Japan.

Polystomoides microrchis Fukui and Ogata 1936a.—From *Ocadia sinensis* in Formosa. See F. and O. 1939.

Polystomoides multifalx (Stunkard 1924) Ozaki 1935.—*Polystoma m.* S.; *Polystoma stunkardi* Harwood 1931. From *Pseudemys floridana* in the United States.

Polystomoides ocadiae Fukui and Ogata 1936a.—From *Ocadia sinensis* in Formosa. See F. and O. 1939.

Polystomoides ocellatum (Rudolphi 1819) Ozaki 1935.—*Polystoma o.* R., *Hexacotyla o.* (R.) de Blainville 1828, *Hexacotyle o.* (R.) B. 1828; *Polystoma mydae* Kuhl and van Hasselt 1822; *Polystoma midas* K. and H. 1824. From *Caretta caretta* and *Emys orbicularis* in Europe. Anatomy—Strankowski 1937.

Polystomoides oris Paul 1938.—From *Chrysemys picta* in the United States.

Nontrematode Reptilian Parasites once Classified as Flukes

Porocephalus crotali (Humboldt 1808) Humbolt 1811.—A porocephalid linguatulid which has been known as *Dist. c.* H., *D. c. durissi* Rudolphi 1809, and *Polystoma proboscideum* R. 1814.

Tetrathyridium lacertae (Valenciennes 1844) Hughes, Baker, and Dawson 1941.—A mesocestoidid cestode larva which has been called *Monost. l.* Diesing 1850, *Tetrathyrus obesus* Creplin 1851, *Petrathyrus o.* (C.) Cobbold 1860, and *M. gurltii* Cobbold 1860.

Studies on Monogenetic Trematodes

VII. Species Infesting the Bluegill Sunfish*

John D. Mizelle and Walter J. Brennan

In 1936 Mueller recorded the first gill parasite, namely, *Cleidodiscus robustus* Mueller, 1934, for the bluegill sunfish. Since that time the list of dactylogyrid species for this host has steadily increased until now there is a total of eleven. Available material from Tennessee and Florida has made possible comparative descriptions of four bluegill species and the addition of two new records for this host. A complete list of bluegill Tetraonchinae, together with information concerning other hosts infested with these, the localities involved, synonymy, etc., is thought to be timely. Quotation marks used in the descriptions indicate that the enclosed measurements and other comparisons were taken from the sources indicated. The Florida specimens were treated as described by Mizelle and Seamster (1939) and the Tennessee material was frozen, preserved, and mounted in a glycerine-jelly medium.

Urocleidus mucronatus (Mizelle, 1936)

Figs. 1-14

Host and Localities: Bluegill Sunfish, *Lepomis macrochirus* Rafinesque, Reelfoot Lake, Ridgely, Tenn., and Lake Okeechobee, Moore Haven, Fla.

Previously Reported Hosts and Localities: Bluegill Sunfish, Lake Senachwine, Henry, Ill.; Illinois State Natural History Survey Pond, Urbana, Ill.; Lake Decatur, Decatur, Ill. (Mizelle 1936); Baton Rouge, La. (Summers and Bennett 1938); Boomer Creek, Stillwater, Okla. (Seamster 1938). Orange-Spotted Sunfish, *Lepomis humilis* (Girard), Salt Lake Fork of the Big Vermilion River, Homer, Ill.; Lake Senachwine, Henry, Ill. (Mizelle 1936); Boomer Creek, Stillwater, Okla. (Seamster 1938). Pumpkinseed Sunfish, *Lepomis gibbosus* Linnaeus, Lake Senachwine, Henry, Ill. (Mizelle 1936). Hybrids from Orange-Spotted and Pumpkinseed and Hybrids from Bluegill and Pumpkinseed Sunfishes, Lake Senachwine, Henry, Ill. (Mizelle 1936).

Synonym: Onchocleidus mucronatus Mizelle, 1936.

Site of Infestation: Gills.

Specimens Studied: Twenty-one.

Comparative Description: Twenty specimens from Reelfoot Lake and one from Lake Okeechobee form the basis for comparison with representatives from Illinois on which the description of the species was made (Mizelle

* Contribution from the Department of Biology, University of Notre Dame, Notre Dame, Indiana.

1936, 1938). Body-size differences in specimens from two Ilinois localities have already been noted (Mizelle 1936). Measurements from a single specimen, obviously, are worth very little for comparative purposes. However, it is interesting to note that of the available measurements (eleven) from the single Florida specimen, those for the haptor (length 0.060 mm, width 0.073 mm), ventral and dorsal anchors (length 0.052 and 0.053 mm resp.), and hooks of pair of number one (length 0.031 mm) were less than the minima obtained for the twenty specimens from Tennessee. Other measurements are within those reported for Tennessee forms. As will be noted from the following, the Illinois specimens average longer than those for more southern (Tenn.) specimens, but this is not true for all of the internal structures. For Tennessee specimens the greatest body width was present (1) near the body mid-region, (2) in the anterior body half, or (3) in the posterior body half. In several specimens a constriction between the level of the vagina and the copulatory complex was present. In such cases the body width was often the same on each side of the constriction. The position of the greatest body width presumably depends on the state of contraction of the parasites at death. The first condition prevailed in most Illinois specimens and is regarded as normal for this species. Body length 0.467 mm (0.336-0.620 mm) "0.503 mm (0.426-0.820 mm)", greatest body width 0.079 mm (0.053-0.103 mm) "0.065 mm (0.051-0.131 mm)". Haptor hexagonal or pentagonal in dorsoventral outline and broader than long, greatest width 0.094 mm (0.077-0.128 mm) "0.101 mm (0.070-0.148 mm)", length 0.087 mm (0.077-0.107 mm) "0.098 mm (0.075-0.139 mm)". The bars which connect members of a pair of anchors were found to be of characteristic shapes in Illinois specimens but exhibit distinct variations in Tennessee representatives. The dorsal bar (Figs. 3-6) is less conservative in this respect than is the ventral bar (Figs. 7, 8). The spines on the bars, when present, are so thin that they may be easily overlooked in flat view but show up plainly in side view (Fig. 9-a). This structure on the dorsal bar always appears entire but on the ventral bar it is always bifurcate. Average ventral bar length 0.022 mm (0.018-0.027 mm) "0.022 mm (0.019-0.024 mm)", average dorsal bar length 0.026 mm (0.021-0.029 mm) "0.024 mm (0.021-0.025 mm." Anchors similar in size and shape (Fig. 9-b and Mizelle 1938, Figs. 24, 25), dorsals slightly longer and with narrower bases; deep roots of both pairs of anchors reduced in length. Average length of ventral anchors 0.061 mm (0.058-0.066 mm) "0.057 (0.051-0.067 mm)", average width of bases 0.016 mm (0.012-0.019 mm) "0.014 mm (0.009-0.019 mm)." Average length of dorsal anchors 0.062 mm (0.056-0.068 mm) "0.057 mm (0.051-0.074 mm)", average width of bases 0.014 mm (0.012-0.017 mm) "0.012 mm (0.009-0.019 mm)." Hooks of pair number one are the largest of the group, situated ventrally on the haptor, and anterior to the ventral bar. Hooks of pair number two lie anteroventrally toward the lateral edge of the haptor; those of pair number three are less ventral and posterior to the preceding; hooks of pair number four lie behind pair three; members of hook pair number five lie between the ventral anchor shafts. Hooks of pairs number six and seven are situated on the dorsal side of the haptor, the latter being more anterior. This arrangement of the

hooks is bilateral and as illustrated for *Urocleidus acer* (Mueller, 1936) (Fig. 19). All of the hooks, except those of pair number five, are of the same general shape. In Tennessee specimens all of the hooks, except those of pairs one, five, and seven are subequal in size; hooks of pair number five being relatively very small while those of one and seven are the largest of the group (both in length and diameter).

Hook pair		
1.	0.040 mm (0.035-0.043 mm)	"0.035 mm (0.030-0.043 mm)"
2.	0.027 mm (0.021-0.030 mm)	"0.026 mm (0.023-0.032 mm)"
3.	0.029 mm (0.026-0.031 mm)	"0.030 mm (0.025-0.037 mm)"
4.	0.032 mm (0.029-0.035 mm)	"0.032 mm (0.028-0.038 mm)"
5.	0.013 mm (0.010-0.016 mm)	"0.013 mm (0.010-0.015 mm)"
6.	0.032 mm (0.026-0.036 mm)	"0.033 mm (0.028-0.038 mm)"
7.	0.039 mm (0.035-0.044 mm)	"0.031 mm (0.028-0.044 mm)"

The hooks of pair one can be distinguished from those of number seven by the fact that they are curved laterad. Hooks of pair number five were observed to possess a short spherical or oval base in Illinois specimens while bases have been infrequently wanting in the present material (Fig. 12). Pharynx circular to ovate in outline (dorsoventral) and 0.024 mm (0.019-0.026 mm) "0.027 mm (0.024-0.029 mm)" in transverse diameter. Cephalic lobes distinct and always present. Eye spots four; members of the anterior pair smaller and almost invariably farther apart than those of the posterior pair. Vagina dextral and diagnostic in that it is connected with a chitinous tube (Fig. 14) which possesses a membrane around its surface which at times presents a very uneven appearance. The accessory piece is essentially the same shape in Illinois and Tennessee forms, average length 0.027 mm (0.022-0.031 mm). The cirrus is straight in Illinois specimens (Mizelle 1938, Fig. 22) and has a cirral thread wound around the shaft but in Tennessee specimens the cirrus is undulate or loosely coiled and may or may not possess a cirral thread (Figs. 1-a, 2-a); cirrus length 0.051 mm (0.043-0.060 mm). Measurements for copulatory structures were not given in the original description. Except for the presence of the accessory piece, the copulatory complex of specimens in which the cirral thread is absent, greatly resembles that of *Urocleidus ferox* Mueller, 1934 (Mueller 1936, pl. 14, figs. 36, 37). In this species (Mueller 1936, pl. 13, fig. 12) however, the bars are not spined as in *U. mucronatus* (Figs. 3, 7, 8, 9-a, and Mizelle 1938, Figs. 26, 27) and the hooks, especially those of pair number five, are very different from those of *U. mucronatus* (Figs. 10-13). The haptor has scalloped edges in *U. ferox*, but is entire in *U. mucronatus*. It seems quite possible that the variations in Tennessee forms serve to connect *U. ferox* and typical *U. mucronatus* specimens. The former species has been taken only from New York State, whereas the latter is recorded from various localities in the middle west and south.

CLEIDODISCUS ROBUSTUS Mueller, 1934

Figs. 15-18

Host and Localities: Bluegill Sunfish, *Lepomis macrochirus* Rafinesque, Reelfoot Lake, Ridgely, Tenn., and Lake Okechobee, Moore Haven, Fla.

Previously Reported Hosts and Localities: Pumpkinseed Sunfish, *Lepomis gibbosus* Linnaeus, State Fish Hatchery Reservoir, Constantia, N. Y. (Mueller 1934), Syracuse, N. Y. (Mueller, 1936). Bluegill sunfish, Hatchery Ponds, London, O. (Mueller 1936); Illinois River, Havana, Ill.; Chautauqua Lake, Havana, Ill.; Horseshoe Lake, Cairo, Ill.; Lake Senachwine, Henry, Ill.; Lake Decatur, Decatur, Ill. (Mizelle 1936). Green Sunfish, *Lepomis cyanellus* Rafinesque, Hatchery Ponds, London, O. (Mueller 1936); Embarrass River, Urbana, Ill. (Mizelle 1938); Urbana, Ill. (Kimpel 1939). "Sunfish" and "Bass," Hatchery Ponds near Syracuse, N. Y. (Mueller 1936).

Site of Infestation: Gills.

Synonyms: Cleidodiscus incisor Mizelle, 1936, and *Actinocleidus incisor* as used by Summers and Bennett (1938).

Specimens Studied: Four.

Comparative Description: Only three specimens of this species from Tennessee and one from Florida were available. Such numbers do not permit valid comparisons with measurements of northern representatives for which twenty specimens were used. However, it is interesting to note that of the twenty different measurements taken, most of them were within the minima and maxima obtained by the senior author in 1936. Minima for haptor length (0.056 mm) and ventral and dorsal bar length (0.024 and 0.022 mm resp.) were less than reported minima for Illinois specimens. These measurements are less also for corresponding measuements for Ohio and New York specimens (Mueller 1934, 1936). Two measurements, namely haptoral (0.150 mm) and body width (0.425 mm) were above the reported maxima. In this work the cirrus and accessory piece which were not measured in Illinois material (Mizelle 1938) are 0.064-0.086 mm and 0.051-0.056 mm, respectively, in length. This cirrus length is somewhat greater than that reported for Ohio and New York material, namely, 0.050 mm and 0.054 mm, respectively (Mueller 1936, 1934).

This species is easily recognized by the singular copulatory complex (Fig. 15) and the vagina (Mizelle 1938, Fig. 15) which possesses a short chitinous tube with a circlet of spines around its base. No striking morphological variations were noted in the southern material except possibly for the presence of more ornate bars (Figs. 17-b, 18-b) in Tennessee specimens.

ACTINOCLEIDUS FERGUSONI Mizelle, 1938

Figs. 27-32

Host and Localities: Bluegill Sunfish, *Lepomis macrochirus* Rafinesque, Reelfoot Lake, Ridgely, Tenn.; Lake Okeechobee, Moore Haven, Fla.; Canal, North Everglade, Fla.

Previously Reported Hosts and Localities: Bluegill Sunfish, Lake Senachwine, Henry, Ill.; Boomer Creek, Stillwater, Okla. (Mizelle 1938). Orange-Spotted Sunfish, Lepomis humilis (Girard), Boomer Creek, Stillwater, Okla. (Seamster 1938).

Site of Infestation: Gills.

Specimens Studied: Four.

Comparative Description: Only three of the twenty different measurements taken on the available Tennessee material (two specimens), were outside the extremes given in the original description. Of these, the minimum for body length (0.266 mm) was less than in Illinois representatives (0.330 mm) and the maxima for the anchor lengths (anterior 0.031 mm, posterior 0.028 mm) were greater than reported in the original description (anterior 0.027 mm, posterior 0.025 mm). With reference to the Florida specimens (two), four measurements were significant when compared with Illinois material. Minima for body length (0.266 mm) and width (0.041 mm) were less than in Illinois specimens (0.330 and 0.045 mm resp.). The cirrus length (0.032-0.047 mm) and anterior bar length (0.034-0.036 mm) presented minima that were greater than Illinois maxima. The following measurements, taken from Florida and Tennessee specimens, are supplementary in that they were not given in the description of the species. Haptor length 0.030-0.051 mm, width 0.043-0.064 mm. Anterior anchor width 0.006-0.011; dorsal anchor width 0.009 mm. The haptoral bars were of characteristic shape in Florida and also in Illinois specimens (Mizelle 1938, Figs. 149, 151) but were quite variable in Tennessee forms (Figs. 27-a, 27-b, 30-b, 30-d). Of these the posterior is most striking in that it sometimes consists of two parts (Fig. 30-b). This variation has also been observed in *Actinocleidus fusiformis* (Mueller 1934) by the senior author (1940). A very closely related species, *A. gracilis* Mueller, 1937, differs mainly from the above by the presence of an undulate cirrus (Mueller 1937, Fig. 17). It is quite possible that these two species represent variations of one species.

UROCLEIDUS ACER (Mueller, 1936)

Figs. 19-26

Host and Localities: Bluegill Sunfish, *Lepomis macrochirus* Rafinesque, Reelfoot Lake, Ridgely, Tenn.

Previously Reported Hosts and Localities: Pumpkinseed Sunfish, *Lepomis gibbosus* Linnaeus, Cross Lake, N. Y. (Mueller 1936). Bluegill Sunfish, Lake Senachwine, Henry, Ill.; Lake Decatur, Decatur, Ill. (Mizelle 1936). Orange-Spotted Sunfish, *Lepomis humilis* (Girard), Lake Senachwine, Henry, Ill. (Mizelle 1936); Boomer Creek, Stillwater, Okla. (Seamster 1938).

Synonyms: Onchocleidus acer Mueller, 1936, and *Pterocleidus acer* (Mueller, 1936) Mueller, 1937.

Site of Infestation: Gills.

Specimens Studied: Seven.

Comparative Description: This parasite, described by Mueller in 1936, is comparatively small and of a typical dactylogyrid shape with a body constriction described for *U. mucronatus* and others, rarely indicated. Body length 0.452 mm (0.389-0.531 mm) "0.35 mm," greatest body width of 0.088 mm

(0.066-0.107 mm) near the body midregion. Haptor (Fig. 19) subpentagonal in dorsoventral outline "rather square in outline." (The junction of the haptor with the peduncle is considered one side of the haptor). Greatest haptoral width 0.084 mm (0.060-0.103 mm), length 0.075 mm (0.060-0.086 mm) "about 0.06 mm. long." Haptoral bars equal or subequal in length. Ventral bar of characteristic shape (Fig. 19-k), length 0.032 mm (0.030-0.035 mm); dorsal bar (Fig. 19-i, 22, 23) variable in shape, length 0.032 mm (0.030-0.035 mm). "Supporting bars of equal size, about 0.03 x 0.07 mm." Anchors similar in size, shape, and with subterminal "spurs"; deep roots reduced in length. Ventral anchors slightly shorter and with bases somewhat wider than those of the dorsal anchors. Average ventral anchor length 0.040 mm (0.036-0.043 mm), width of base 0.015 mm (0.013-0.023 mm); average dorsal anchor length 0.044 mm (0.041-0.045 mm), width of base 0.015 mm (0.013-0.017 mm) "Anchors 0.045-0.05 mm in greatest straight dimension." Hooks fourteen in number, with typical arrangement (Fig. 19), and subequal in length, except for members of pair number five which are relatively small. Hook bases (except those of number five) elongate, longer than the hook shafts, and sometimes apparently absent (Fig. 19-a). Each hook with a well-developed sickle-shaped termination and an opposable piece. Hooks of pair number five situated between the ventral anchor shafts and with oval to spherical bases which are comparatively short in relation to the shafts (Fig. 19-e). Hook length of pairs: number one 0.022 mm (0.021-0.024 mm), two 0.019 mm (0.017-0.021 mm), three 0.020 mm (0.017-0.023 mm), four 0.020 mm (0.018-0.021 mm), five 0.012 mm (0.011-0.013 mm), six 0.020 mm (0.017-0.022 mm), and seven 0.022 mm (0.021-0.024 mm). "Fourteen hooks present, — first pair slightly larger than the others." The hooks illustrated by Mueller (1936, pl. 13, fig. 9) have no bases, no sickle-shaped terminations, nor opposable pieces. These differences in hook structure are very unusual. Eye spots four, members of the posterior pair larger and generally closer together than those of the anterior pair. Cephalic lobes small but distinct. Pharynx circular in dorsoventral outline and 0.027 (0.026-0.030 mm) in transverse diameter. "Pharynx 0.02 mm. in diameter." Vagina dextral. The copulatory complex consists of a cirrus and cirral "fin" of a variable nature (Figs. 20-c, 21-b) and at times possesses an accessory piece (Fig. 20-b). In all cases it differs from that figured in the original description (Mueller 1936, pl. 14, fig. 35) in that the cirral thread arises less proximally, makes fewer turns around the shaft, and is much less regular in aspect. Cirrus length 0.056 mm (0.047-0.064 mm) "0.05 mm. long." Gonads ovoid in outline, subequal in size, and tandem in arrangement; testis posterior. Observed differences between these specimens and those used in the original description are very striking but are not considered of sufficient magnitude to warrant the description of a new species.

ACTINOCLEIDUS BURSATUS (Mueller, 1936)

Host and Locality: Bluegill Sunfish, *Lepomis macrochirus* Rafinesque, Lake Okechobee, Moore Haven, Fla.

Previously Reported Hosts and Localities: Large-Mouth Bass, *Huro salmoides* (Lacépède), London, O. (Mueller 1936); Peace River, Fla. (Mueller 1937). Kentucky or Spotted Bass, *Micropterus punctulatus* (Rafinesque) and Small-Mouth Bass, *Micropterus dolomieu* Lacépède, Cove Creek, Caryville, Tenn. (Mizelle 1940).

Site of Infestation: Gills.

Synonym: Ancyrocephalus bursatus Mueller, 1936.

Only one specimen (contorted) of this species was recovered from the above host (bluegill). It is thought that the bluegill is an ectopic host for this parasite. (New record).

ACTINOCLEIDUS GRACILIS Mueller, 1937

Reported Host and Locality: Lepomis macrochirus Rafinesque, Fla. (Mueller 1937).

Site of Infestation: Gills.

This species has not yet been recovered from Tennessee nor the present Florida material.

UROCLEIDUS ATTENUATUS Mizelle, 1941

Host and Locality: Bluegill Sunfish, *Lepomis macrochirus* Rafinesque, Canal, North Everglades, Fla.

Previously Reported Host and Localities: Stump-Knocker Sunfish, *Lepomis microlophus* (Günther), Englewood Pond, Englewood, Fla.; Everglades Canal, Naples, Fla.; Lake Okeechobee, Moore Haven, Fla. (Mizelle 1941a).

Site of Infestation: Gills.

Only one specimen was recovered from the bluegill. The body length (0.372 mm), body width (0.090 mm), cirrus length (0.077 mm), and dorsal bar length (0.021 mm) in this specimen were less than the minima reported for corresponding measurements in the original description. Other measurements were between the minima and maxima reported (Mizelle 1941). The bluegill is possibly an ectopic host for this species. (New record).

UROCLEIDUS BIRAMOSUS (Mueller, 1937)

Host and Locality: Bluegill Sunfish, *Lepomis macrochirus* Rafinesque, Lake Okeechobee, Moore Haven, Fla.

Previously Reported Host and Locality: Bluegill Sunfish, Fla. (Mueller 1937).

Site of Infestation: Gills.

Synonym: Pterocleidus biramosus Mueller, 1937.

One specimen (poor) of this species was recovered from the bluegill from Lake Okeechobee.

UROCLEIDUS DISPAR (Mueller, 1936)

Reported Hosts and Localities: Pumpkinseed Sunfish, *Lepomis gibbosus* Linnaeus, Constantia, N. Y. (Mueller 1936); Bluegill Sunfish, *Lepomis macrochirus* Rafinesque, Illinois, (Mizelle 1938). Orange-Spotted Sunfish, *Lepomis humilis* (Girard), Boomer Creek, Stillwater, Okla. (Seamster 1938).

Site of Infestation: Gills.

Synonyms: Onchocleidus dispar Mueller, 1937; *Haplocleidus dispar* (Mueller, 1936) Mueller, 1937.

This species has not been recorded from Tennessee nor Florida.

UROCLEIDUS PERDIX (Mueller, 1937)

Reported Host and Locality: Bluegill Sunfish, *Lepomis macrochirus* Rafinesque, Fla. (Mueller 1937).

Site of Infestation: Gills.

Synonym: Onchocleidus perdix Mueller, 1937.

No specimens of this species were recovered from Tennessee nor the present Florida material.

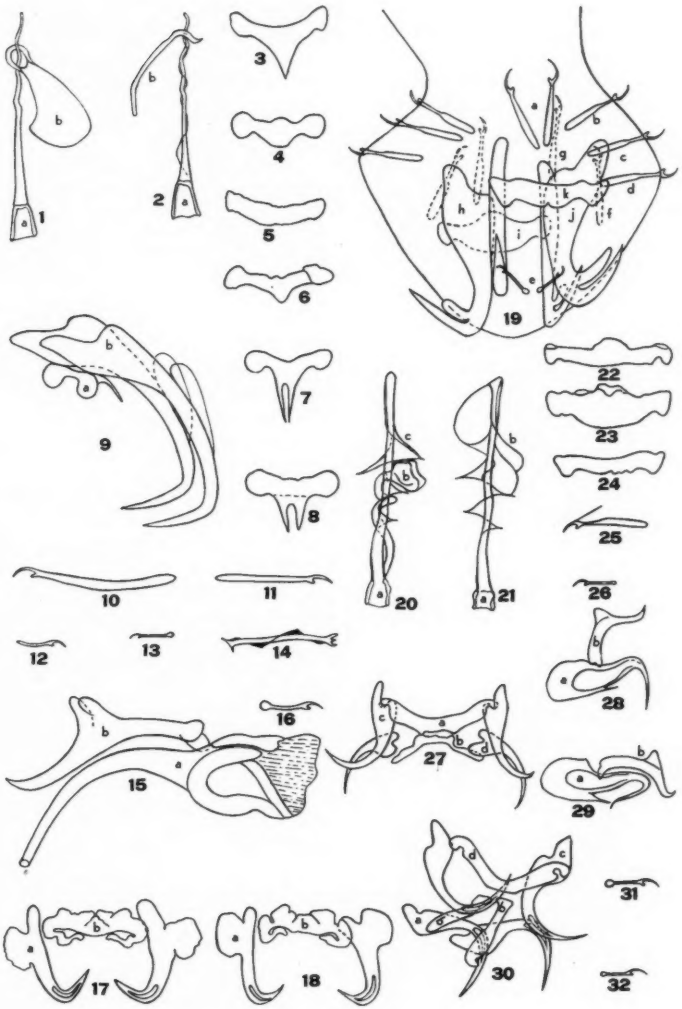
EXPLANATION OF PLATE

Figs. 1-14. *Urocleidus mucronatus* (Mizelle, 1936). 1-a, 2-a. Cirri. 1-b, 2-b. Accessory pieces. 3-6. Dorsal bars. 7, 8, 9-a. Ventral bars. 9-b. Ventral anchor. 10. Hook No. 1. 11. Hook No. 3. 12, 13. Hooks No. 5. 14. Vaginal tube.

Figs. 15-a-18-b. *Cleidodiscus robustus* (Mueller, 1934). 15-a. Cirrus. 15-b. Accessory Piece. 16. Hook. 17-a. Ventral anchor. 17-b. Ventral bar. 18-a. Dorsal anchor. 18-b. Dorsal bar.

Figs. 19-a-26. *Urocleidus acer* (Mueller, 1937). 19-a. Hook no. 1. 19-b. Hook No. 2. 19-c. Hook No. 3. 19-d. Hook No. 4. 19-e. Hook No. 5. 19-f. Hook No. 6. 19-g. Hook No. 7. 19-h. Dorsal anchor. 19-i, 22, 23. Dorsal bars. 19-j. Ventral anchor. 19-k, 24. Ventral bars. 20-a, 21-a. Cirri. 20-b. Accessory piece. 20-c, 21-b. Cirral threads. 25. Hook No. 1. 26. Hook No. 5.

Figs. 27-a-32. *Actinocleidus fergusoni* Mizelle, 1938. 27-a, 30-d. Anterior bars. 27-b, 30-b. Posterior bars. 27-c, 30-c. Anterior anchors. 27-d, 30-a. Posterior anchors. 28-a, 29-a. Cirri. 28-b, 29-b. Accessory pieces. 31, 32. Hooks.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ANCHORADISCUS ANCHORADISCUS Mizelle, 1941

Reported Hosts and Localities: Stumpknocker Sunfish, *Lepomis microlophus* (Günther), Englewood Ditch, Englewood, Fla.; Myakka River, State Park, East Sarasota, Fla.; Lake Okeechobee, Moore Haven, Fla.; Everglades Canal, Naples, Fla. Bluegill Sunfish, *Lepomis macrochirus* Rafinesque, Canal, North Everglades, Fla. (Mizelle 1941).

Site of Infestation: Gills.

This parasite has not been found in the present Tennessee material.

Grateful acknowledgment is hereby made to Dr. R. V. Bangham of the College of Wooster, Wooster, Ohio, who collected and sent the Florida material to the senior author; to Dr. Carl Venard of the Ohio State University, Columbus, Ohio, who furnished the parasites from Tennessee; and to the Tennessee Academy of Science which made it possible for Dr. Venard to collect his portion of the material treated herein.

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Studies on Monogenetic Trematodes

VIII. Tetraonchinae Infesting Lepomis miniatus Jordan*

John D. Mizelle and Benedict J. Jaskoski

Several papers have appeared lately, dealing with Tetraonchinae from given fish hosts. A collection of *Lepomis miniatus* Jordan, from Reelfoot Lake, Ridgely, Tennessee, has provided material for the first information of this type for the above host. A total of eight species of parasites has been recovered. Six of these are new to science while the other two have been described from other Centrarchidae. In each case the infestations were restricted to the gills of the host.

Measurements enclosed by quotation marks are taken from the sources indicated. Other measurements (not enclosed) are those obtained from the material treated herein. Although anchor wings are not shown on all figures (for anchors) they almost invariably occur in all species of fresh-water Tetraonchinae. These structures may be very weakly to very strongly developed.

Actinocleidus brevicirrus n. sp.

Figs. 42-48

Specimens Studied: Two.

Type Specimens: Cotypes, U. S. Nat. Mus. Washington, D. C.

Description: Small dactylogyrids with a smooth cuticula. Length 0.338-0.451 mm, greatest body width 0.063 mm. Peduncle of moderate length. Haptor discoidal, width 0.063-0.067 mm, length 0.039-0.054 mm. Haptoral bars dissimilar; anterior bar bent posteriorly in middle and articulated with the modified ventral bar. Articulating surfaces of bars well developed (Figs. 43, 45). Anterior bar notched near each end, posterior bar with ends developed posteriorly to present two prominent limbs. Anterior bar length 0.042-0.049 mm, posteriorly bar length (in reality the width) 0.025-0.032 mm. Anchors with dissimilar bases and with regularly recurved solid shafts and points. Anterior anchor bases slightly bifurcate, posterior anchor bases with vestigial roots (Figs. 42, 44). Length of anterior anchors 0.034-0.036 mm, width of bases 0.010-0.012 mm. Length of posterior anchors 0.032-0.034 mm, width of bases 0.009-0.012 mm. Hooks fourteen in number and with little variation in length, arrangement normal (Mizelle 1938). Each hook consists of a short oval base, a slender solid shaft, a sickle-shaped termination, and an opposable piece (Fig. 46). Hook lengths 0.009-0.014 mm. Eye spots four, members of the posterior pair larger and closer together than those of the

* Contribution from the Department of Biology, University of Notre Dame, Notre Dame, Indiana.

anterior pair. Cephalic lobes vestigial. Pharynx circular in outline, transverse diameter 0.019-0.027 mm. Heavy development of the vitellaria did not permit observation of the gonads. Vagina sinistral, near midlength of body margin; seminal receptacle not observed. Copulatory complex consisting of a cirrus and an accessory piece (Figs. 47, 48). Cirrus with a comparatively large base and a smaller portion which tapers to a fine point, length 0.023-0.027 mm. Accessory piece solid, attached to the cirrus base and appears to make a half-turn around the cirrus, length 0.020 mm. Seminal vesicle not observed. Vitellaria greatly developed and consisting of very numerous follicles of various sizes.

The cirrus of this species, except for size, vaguely resembles that of *Actinocleidus fusiformis* (Mueller 1934). The accessory piece, however, is very different from that of this species and reciprocal infestations have not been found to occur.

Actinocleidus subtriangularis n. sp.

Figs. 33-41

Specimens Studied: One.

Type Specimen: Type, U. S. Nat. Mus. Washington, D. C.

Description: Small dactylogyrids with a smooth cuticula. Length 0.381 mm, greatest body width 0.040 mm. Peduncle of moderate size. Haptor discoidal, width 0.053 mm, length 0.040. Haptoral bars dissimilar (Figs. 34, 36). Anterior bar remotely similar to that of *Actinocleidus brevicirrus* n. sp., posterior bar with articulating surfaces prolonged to form two short arms which together with the two posteriorly projecting arms produce a vague H-shaped structure. Anterior bar length 0.044 mm, posterior bar length 0.021 mm. Anchors similar in size and shape; bases slightly bifurcate, shafts and points solid and regularly recurved (Figs. 33, 35). Length of anterior anchors 0.031 mm, width of bases 0.013 mm. Length of posterior anchors 0.030 mm, width of bases 0.013 mm. Hooks fourteen in number, all of the same shape, subequal in length, and of normal arrangement (Mizelle 1938). Each hook consists of a solid oval base, a slender solid shaft, a sickle-shaped termination, and a small opposable piece (Fig. 37). Hook lengths 0.012-0.014 mm. Eye spots four, posterior pair larger; spatial relationship of eye spots could not be seen in the side view of the specimen. Cephalic lobes not discernible. Pharynx circular in outline (side view), transverse diameter 0.016 mm. Gonads and seminal vesicle not observed. Vagina conspicuous, sinistral, situated in the anterior half of the body, and with spines near its junction with the seminal receptacle. Copulatory complex consisting of a sigmoid cirrus and a vestigial accessory piece (Figs. 40, 41). Cirrus with a large base and pointed tip, length 0.026 mm. Accessory piece broadly articulated with cirrus and subtriangular in shape, greatest length 0.013 mm. Vitellaria poorly developed and terminate near the base of the peduncle.

Several species (*A. maculatus* Mueller, 1937, *A. articularis* Mizelle, 1936, and others) of this genus possess a sigmoid cirrus but none of them has an

accessory piece that even vaguely resembles that of *A. subtriangularis* n. sp. The vagina and seminal receptacle (Figs. 38, 39) of this form are also distinctive.

Cleidodiscus venardi n. sp.

Figs. 49-61

Specimens Studied: Three.

Type Specimens: Cotypes, U. S. Nat. Mus. Washington, D. C.

Description: Moderately large dactylogyrids with a smooth cuticula. Average length 0.992 mm (0.902-1.043 mm), greatest body width average 0.188 mm (0.169-0.226 mm). Peduncle moderate to extremely long. Haptor irregularly discoidal in shape, width 0.095 mm (0.080-0.113 mm), length 0.072 mm (0.057-0.087 mm). Haptoral bars similar, consistent in shape, and with the ends bent under (Figs. 51, 52, 54, 55). Attachment of bars to anchors is apparently made to the mesiolateral surfaces of the latter. Ventral bar length 0.024 mm (0.023-0.027 mm), dorsal bar length 0.025 mm (0.023-0.028 mm). Anchors of moderate size, generally similar in size and shape, and with regularly recurved hollow shafts and points; ventrals variable in size and often with very wide bases (Figs. 49, 50, 53). Anchor bases slightly bifurcate, deep roots reduced to roughened knobs. Length of ventral anchors 0.025 mm (0.022-0.027 mm), width of base 0.015 mm (0.011-0.019 mm). Length of dorsal anchors 0.023 mm (0.022-0.024 mm), width of bases 0.011 mm (0.009-0.013 mm). Hooks fourteen, similar in size (in a given specimen) and shape, and arrangement normal with members of pairs number five located between the two pairs of anchors but nearer to the ventral pair. Each hook consists of an oval base, a solid shaft, a sickle-shaped termination, and a small opposable piece (Fig. 59). Hooks of pair number one slightly shorter than the others. Hook lengths 0.013-0.019 mm. Eye spots four, members of the posterior pair larger and farther apart or closer together than those of the anterior pair. Cephalic lobes small. Pharynx circular in dorsoventral outline, diameter 0.062 mm (0.053-0.067 mm). Gonads not observed. Vagina conspicuous, sinistral, and situated in the anterior body third. Copulatory complex consisting of a sickle-shaped cirrus and an accessory piece. Cirrus length 0.056 mm (0.039-0.064 mm). Accessory piece blade-like in side view and with a conspicuous but variable knob near its midlength (Figs. 56, 57). Accessory piece length 0.042 mm (0.039-0.044 mm). Cirrus and accessory piece articulated basally with each other. Vitellaria consisting of numerous fine follicles which may extend into the moderate to slender peduncle.

Cleidodiscus robustus Mueller, 1934, is perhaps the closest relative of this species. The haptoral armament and copulatory complexes are of the same type but at the same time are very different in detail (Figs. 49-59 and Mizelle 1938, Figs. 13-21). The vagina and seminal receptacles of the two species are distinctive (Figs. 60, 61 and Mizelle 1938, Figs. 15, 17). *Actinocleidus gracilis* Mueller, 1937, and *A. fergusoni* Mizelle 1938, both possess an accessory piece similar to that of the present species but have haptoral bars of a type peculiar to another genus.

UROCLEIDUS ATTENUATUS Mizelle, 1941

Figs. 11-24

Previously Reported Hosts and Localities: Stump-Knocker Sunfish, *Lepomis microlophus* (Günther), Englewood Pond, Englewood, Fla.; Everglades Canal, Naples, Fla., and Lake Okeechobee, Moore Haven, Fla. (Mizelle 1941). Bluegill Sunfish, *Lepomis macrochirus* Rafinesque, Canal, North Everglades, Fla. (Mizelle and Brennan 1942).

Specimens Studied: Three.

Measurements of specimens of this species from Reelfoot Lake *Lepomis miniatus* agree with those in the original description except that the minima for 1) body width (0.098 mm, "0.108 mm"), 2) ventral bar length (0.018 mm, "0.024 mm"), 3) dorsal bar length (0.021 mm, "0.026 mm"), and 4) cirrus (0.063 mm "0.081 mm") are smaller. The accessory piece is shorter in Tennessee forms (Figs. 17, 20 and Mizelle 1941, Figs. 25, 26). Structurally (qualitatively) the specimens from Tennessee and Florida are the same except that a short cirral thread is present in Reelfoot Lake forms. The pharynx diameter (transverse) 0.046 mm (0.038-0.053 mm) supplemented here for Florida forms, is less, 0.049 mm (0.043-0.057 mm), than in specimens from Tennessee.

UROCLEIDUS CHAENOBRYTTUS Mizelle and Seamster, 1939

Figs. 74-82

Previously Reported Host and Localities: Warmouth Bass, *Chaenobryttus gulosus* (Cuvier and Valenciennes), Roadside Canal, Naples, Fla.; Roadside Ditch, Englewood, Fla., and Woodmere Pond, Englewood, Fla. (Mizelle and Seaster 1939).

Specimens Studied: One.

The single specimen of this species available from *L. miniatus* possesses characteristics which are common to *U. mucronatus* Mizelle 1936, and *U. chaenobryttus* Mizelle and Seamster 1939. However, it is more like the latter species in many respects and is therefore regarded as a normal variant of it. A comparative study of Tetraonchinae of the warmouth bass is in progress. Advance information from this source supports the contention that the specimen dealt with here is a variant of *U. chaenobryttus*. Measurements obtained agree with those in the original description except as follows: 1) body length of 0.494 mm "0.245-0.380 mm", 2) haptor length 0.100 mm "0.067-0.094 mm", 3) ventral anchor width 0.017 mm "0.012-0.015 mm", and 4) hook lengths 0.038-0.043 mm "0.032-0.040 mm". Structurally the anchors resemble those of both its near relatives. The bars are both spined as in *U. mucronatus;* the dorsal bar only is spined in *U. chaenobryttus*. The presence of an accessory piece (Fig. 79) renders it different from descriptions of both species mentioned. The presence of this structure in this genus is not surprising but

in that it is articulated with the cirrus base as is generally the case in the genera *Cleidodiscus* Mueller, 1934, and *Actinocleidus* Mueller, 1937, is most unusual.

Cleidodiscus chelatus n. sp.

Figs. 1-10

Specimens Studied: One.

Type Specimen: Type, U. S. Nat. Mus. Washington, D. C.

Description: Moderately small dactylogyrids with a smooth cuticula. Length 0.451 mm, greatest body width 0.056 mm. Peduncle narrow and of moderate length. Haptor hexagonal in dorsoventral outline, width 0.070 mm, length 0.047 mm. Haptoral bars dissimilar (Figs. 2, 4). Ventral bar relatively large, narrowly bent in the midportion and near each end, length 0.038 mm. Dorsal bar smaller, broadly bent in the middle and with rounded ends, length 0.030 mm. Anchors similar in shape, and with regularly recurved solid shafts and points; ventrals larger. Anchor bases deeply bifurcate (Figs. 1, 3). Length of ventral anchors 0.031 mm, width of bases 0.014 mm. Length of dorsal anchors 0.027 mm, width of bases 0.012 mm. Hooks fourteen in number, subequal in length and normal in arrangement. Hooks of pair number five lie between the bars—nearer to the ventral. Each hook is composed of a solid base, a solid shaft, a sickle-shaped termination, and a small opposable piece (Figs. 5, 6). The bases and shafts are of almost the same length in all the hooks except those of pair number five in which the bases are much shorter than the shafts. Hook lengths 0.013-0.016 mm. Eye spots four, fragile, and break up readily with cover-glass pressure. Members of the posterior pair larger; spatial relationships of eye spots not determined due to separation of constituent granules. Cephalic lobes vestigial, pharynx circular in dorsoventral outline, diameter 0.027 mm. Ovary subcircular in dorsoventral outline, testis obscured by vitellaria. Vagina small, sinistral, and situated in the posterior part of the anterior body half; seminal receptacle elliptical in outline (Fig. 8). Copulatory complex consisting of an attenuate cirrus and a chelate accessory piece. Cirrus with a large base to which the accessory piece attaches, length 0.022 mm. Accessory piece with the upper blade of the chela pointed, lower blade terminally blunt and with a raised area on the inner surface (Fig. 10), length 0.023 mm. Vitellaria greatly developed and consisting of follicles of different sizes, some of which extend into the basal portion of the peduncle.

The closest relative of this species is *Cleidodiscus bedardi* which was described from the long-eared sunfish by Mizelle in 1936. The copulatory complexes and haptoral armament of these two species are similar superficially (Figs. 1-6 and 9, 10 and Mizelle, 1938, Figs. 57-62). The present species, however, lacks the pseudovagina of *C. bedardi* and when details of all superficially similar structures of both species are closely observed, they reveal many differences. *C. bedardi* has been recovered only from the long-eared sunfish, *Lepomis megalotis* (Rafinesque).

Urocleidus miniatus n. sp.

Figs. 25-32

Specimens Studied: Thirteen.

Type Specimens: Cotypes, U. S. Nat. Mus. Washington, D. C.

Description: Small dactylogyrids with a smooth cuticula. Average length 0.342 mm (0.282-0.423 mm), greatest body width 0.056 mm (0.039-0.085 mm). Peduncle short to moderate in length. Haptor irregularly pentagonal to hexagonal in dorsoventral outline, width 0.066 mm (0.049-0.074 mm), length 0.059 mm (0.050-0.080 mm). Haptoral bars dissimilar and variable in shape. Ventral bars with knobbed ends and gently bent posteriorly in the midportion (Fig. 26). Dorsal bar slightly bent posteriorly in the middle, with rounded to knobbed ends, and very often enlarged in the midportion. Ventral bar often with a median posterior spine, length 0.024 mm (0.021-0.026 mm), dorsal bar length 0.024 mm (0.019-0.026 mm). Anchors similar in size and shape and each with a spur-like structure on the distal portion of the shaft. The solid shafts and points unite to form an angle; deep roots of bases very small (Figs. 25, 27). Length of ventral anchors 0.042 mm (0.039-0.046 mm), width of bases 0.010 mm (0.007-0.017 mm). Length of dorsal anchors 0.043 mm 0.039-0.048 mm), width of bases 0.010 mm (0.008-0.012 mm). Hooks fourteen in number and subequal (except for members of pair five) in length in a given specimen. Each hook of pairs number 1, 6, and 7 is composed of an elongate shaft, a sickle-shaped termination, and an opposable piece. Other hooks with a base and shaft in addition to the terminal structures. Base (infrequently wanting) of each member of pair number five oval, shorter than the shaft (Fig. 31), others with bases longer than shafts. Hook arrangements characteristic with pair number five situated between the ventral anchor shafts. Hook lengths 0.009-0.028 mm, members of pair number five roughly one-half as long as the others (Fig. 32). Eye spots four, irregularly ovate in shape with members of the posterior pair two to four times larger and much closer together than those of the anterior pair. Cephalic lobes well developed. Pharynx circular to ovate in outline, transverse diameter 0.020 mm (0.014-0.023 mm). Gonads obscured by vitellaria. Vagina conspicuous, dextral, and situated in the posterior part of the anterior body half; vaginal tube longer than width of body. Copulatory complex consisting of a corkscrew cirrus and an accessory piece (Figs. 29, 30). Cirrus length 0.037 mm (0.025-0.043 mm). Accessory piece very thin and bifurcate terminally, length 0.020 mm (0.016-0.026 mm). Cirrus and accessory piece nonarticulate with each other. Vitellaria moderately developed and terminate on the peduncle.

This species is similar to others in the genus which possess "spurred" shafts but differs radically from all of them in the nature of the cirrus and accessory piece.

Urocleidus parvicirrus n. sp.

Figs. 62-73

Specimens Studied: Two.

Type Specimens: Cotypes, U. S. Nat. Mus. Washington, D. C.

Description: Moderately small dactylogyrids with a smooth cuticula. Length 0.423-0.465 mm, greatest body width 0.085 mm. Peduncle of moderate length; haptor poorly defined, length 0.067 mm. The dorsoventral outline of the haptor is difficult to determine in species with extremely large anchors in that they cause it to lie on its side. Haptoral bars dissimilar (Figs. 63, 65). Ventral bar with rounded ends and a short posteriorly projecting median spine. Dorsal bar with knobbed ends and gently bent posteriorly in the midportion. Ventral bar length 0.018 mm, dorsal bar length 0.021-0.026 mm. Anchors dissimilar, bases slightly bifurcate, and with solid shafts and points which form an angle at their junction (Figs. 62, 64). Length of ventral anchors 0.036-0.040 mm, width of bases 0.011 mm. Length of dorsal anchors 0.071-0.073 mm, width of bases 0.013 mm. Hooks fourteen in number and with little variation in length in a given specimen. Each hook composed of an elongate base, a solid shaft, a sickle-shaped termination, and a small opposable piece (Figs. 67, 68). Hooks of pairs numbers one and five with bases shorter than their shafts, bases of rest of hooks approximately the same length as their respective shafts. Hook lengths 0.014-0.020 mm. Eye spots four, members of the posterior pair larger and closer together than those of the anterior pair. Cephalic lobes small but conspicuous. Pharynx ovate to circular in dorsoventral outline, transverse diameter 0.031 mm (0.030-0.033 mm). Gonads not observed, vagina dextral and situated in the posterior part of the anterior body half. Copulatory complex consisting of a corkscrew-like cirrus and an accessory piece. Cirrus with corkscrew part of small diameter, total length 0.028 mm. Accessory piece bifurcate terminally (Figs. 70, 72), length 0.014 mm. Cirrus and accessory piece nonarticulate with each other. Vitellaria moderately developed and terminate on the peduncle near the haptor.

The very short cirrus which may be termed the "drill type" together with the shorter accessory piece renders this species very different from all other members of the genus. The wide discrepancy in anchor size is not restricted to this species.

The authors wish to express their thanks and appreciation to Dr. Carl Venard of Ohio State University for kindly supplying the material used in this study, and also to the Tennessee Academy of Science which facilitated Dr. Venard's activities by means of a grant.

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EXPLANATION OF PLATE

All figures were drawn at the same magnification with the aid of a camera lucida.

Figs. 1-10. *Cleidodiscus chelatus* n. sp. 1. Ventral anchor. 2. Ventral bar. 3. Dorsal anchor. 4. Dorsal bar. 5. Hooks of pair No. one. 6. Hooks of pair no. five. 7. Vagina. 8. Seminal receptacle. 9. Cirrus. 10. Accessory piece.

Figs. 11-24. *Urocleidus attenuatus* Mizelle, 1941. 11. Ventral anchor. 12. Ventral bar. 13. Dorsal anchor. 14. Dorsal bar. 15. Hooks of pair No. one. 16. Hooks of pair No. five. 17, 20. Accessory pieces. 18, 21. Cirri. 19, 22. Cirral threads. 23. Vagina. 24. Seminal receptacle.

Figs. 25-32. *Urocleidus miniatus* n. sp. 25. Ventral anchor. 26. Ventral bar. 27. Dorsal anchor. 28. Dorsal bar. 29. Accessory piece. 30. Cirrus. 31. Hooks of pair No. five. 32. Hooks of ordinary type.

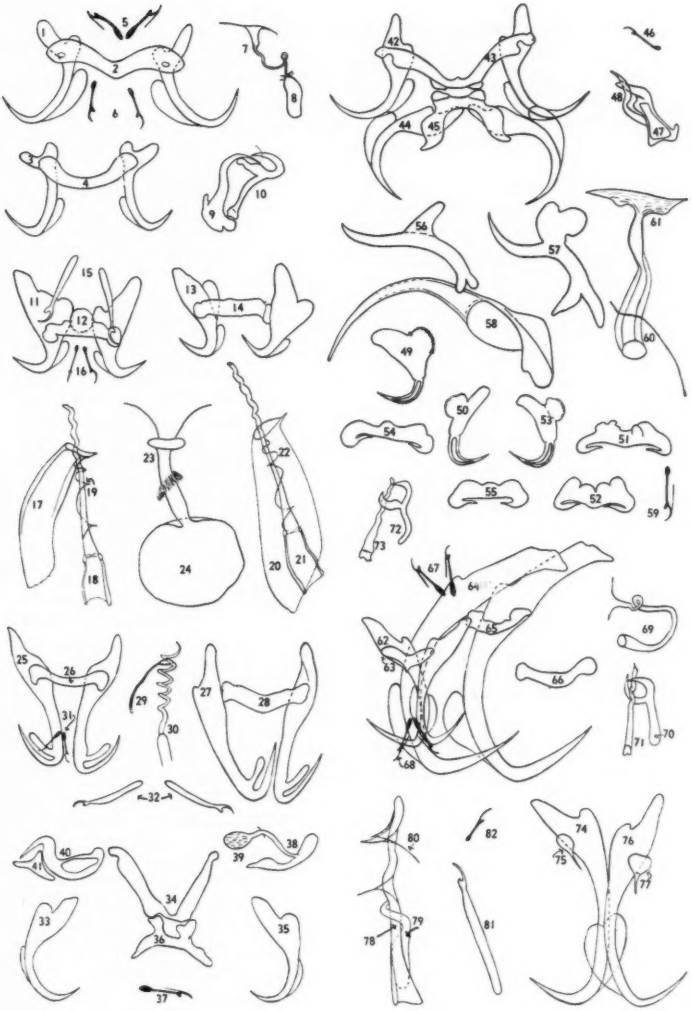
Figs. 33-41. *Actinocleidus subtriangularis* n. sp. 33. Anterior anchor. 34. Anterior bar. 35. Posterior anchor. 36. Posterior bar. 37. Hook. 38. Vagina. 39. Seminal receptacle. 40. Cirrus. 41. Accessory piece.

Figs. 42-48. *Actinocleidus brevicirrus* n. sp. 42. Anterior anchor. 43. Anterior bar. 44. Posterior anchor. 45. Posterior bar. 46. Hook. 47. Cirrus. 48. Accessory piece.

Figs. 49-61. *Cleidodiscus venardi* n. sp. 49, 50. Ventral anchors. 51, 52. Ventral bars. 53. Dorsal anchor. 54, 55. Dorsal bars. 56, 57. Accessory pieces. 58. Cirrus. 59. Hook. 60. Seminal receptacle. 61. Vagina.

Figs. 62-73. *Urocleidus parvicirrus* n. sp. 62. Ventral anchor. 63. Ventral bar. 64. Dorsal anchor. 65, 66. Dorsal bars. 67. Hooks of pair No. one. 68. Hooks of pair No. five. 69. Vagina. 70, 72. Accessory pieces. 71, 73. Cirri.

Figs. 74-82. *Urocleidus chaenobryttus* Mizelle and Seamster, 1939. 74. Ventral anchor. 75. Ventral bar. 76. Dorsal anchor. 77. Dorsal bar. 78. Cirrus. 79. Accessory piece. 80. Cirral thread. 81. Hook of ordinary type. 82. Hook of pair No. five.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Amphibians and Reptiles from Dutch Mountain (Pennsylvania) and Vicinity

Roger Conant

It twice has been my privilege to spend vacation periods in a portion of Pennsylvania which, not only is imperfectly known, herpetologically speaking, but which, except for having been lumbered about forty years ago, has suffered a minimum of disturbance through the presence of human beings. From this area, and several nearby localities, a considerable number of amphibians and reptiles has been assembled for study, in brief, some four hundred and ninety specimens, representing twenty-four species. While it is admitted that the list, here presented, doubtless is incomplete, it is deemed advisable to publish upon the material now available. Several days of intensive collecting in spring probably would add a number of conspicuous absentees to the list, but when I shall be able to return to the region seems problematical; eight years elapsed between the two visits I have made.

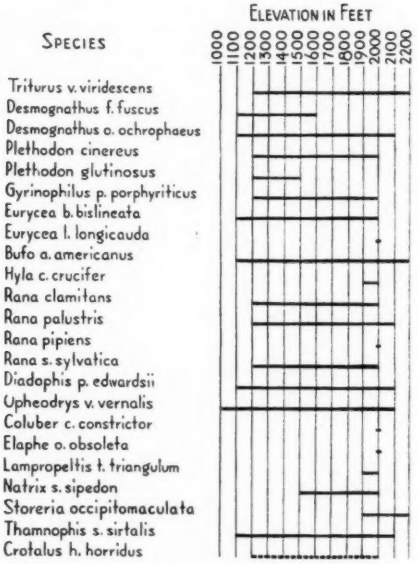
Dutch Mountain, a spur of the larger and better known North Mountain, originates in the glaciated plateau country surrounding Lopez, Sullivan County, and extends to the northeast nearly to Forkston, Wyoming County, a distance of approximately ten miles. On its comparatively broad top, which exhibits moderate relief, are several extensive tamarack-sphagnum bogs; some of these constitute the headwaters of the Loyalsock Creek, an important stream that flows to the west. The southeast slope of the mountain descends very rapidly to the valley of the Mehoopany Creek. Elevations vary from more than 2300 feet at the summit to less than 1000 feet along Mehoopany Creek. The elevations at which the various species of amphibians and reptiles were found are indicated upon the accompanying chart.

Geologically, Dutch Mountain is composed of shales, sandstones and conglomerates which outcrop extensively in many places. Glacial boulders also are very abundant, particularly on the top and upper slopes. The original, or climax forest consisted chiefly of spruce and hemlock, but the mixed mesophytic second growth of today is mainly of beech-birch-maple association. Pure stands of hemlock are numerous, however, especially in the more precipitous ravines.

Much collecting also was done to the west and south of Dutch Mountain. This region, owing to glaciation, with its consequent deposition of till and damming of previously existing drainage systems, contains numerous swamps, ponds and lakes, all of which form excellent habitats for many kinds of amphibians and reptiles. The country south of Dutch Mountain is heavily forested, but to the north and west there is considerable farming and some

coal mining, both of which activities have extensively disturbed natural conditions. Conversely to what might be expected, however, one of the most productive localities visited was along the banks of the considerably polluted Little Loyalsock Creek, in farming country about a mile below Dushore. Two of the species which were found to occur there in numbers, *Rana pipiens* and *Eurycea l. longicauda,* were not collected elsewhere.

Cold, rainy weather prevailed during the first visit to Dutch Mountain and vicinity, from September 24 to 29, 1932. During the second trip, from August 9 to 30, 1940, it was at first dry and warm and the low levels of the streams gave indication of the lack of rain. Later there was considerable precipitation and day after day was cold and rainy. According to the United States Weather Bureau, the general area with which this paper is concerned receives an average of upwards of 40 inches of rainfall per annum. The nearest weather station (at Muncy Valley) reports an average annual precipitation of 43.12 inches.



All localities mentioned in this paper are listed below. With the exception of the above mentioned one along the Little Loyalsock Creek, all are shown on the Harvey Lake, Laporte and Eagles Mere Quadrangles of the United States Geological Survey. The approximate elevations of each collecting station (indicated in parentheses) are taken from these maps. Localities, with some exceptions, are indicated in the text solely by their respective key letters.

LOCALITIES

A.—3 miles east of Lopez, Sullivan County (1900 to 2000). This locality is known locally as Shady Nook.

B.—2 miles east of Lopez, Sullivan County (1900).

C.—Santee Creek, 4 miles east of Lopez, Sullivan County (2000).

D.—1 mile southeast of Lopez, Sullivan County (1900).

E.—Top of Dutch Mountain, Forkston Township, Wyoming County (2200).

F.—Top of Dutch Mountain, Colley Township, Sullivan County (2100).

G.—Becker Brook, Dutch Mountain, Forkston Township, Wyoming County (2000).

H.—Southeast slope of Dutch Mountain, Forkston Township, Wyoming County (1200 to 2000).

I.—Stony Brook, Dutch Mountain, Forkston Township, Wyoming County (1100 to 1300).

J.—Rocky Run, Colley Township, Sullivan County (1900).

K.—Ficht Pond, Forkston Township, Wyoming County (2000).

L.—Rouse Pond, Colley Township, Sullivan County (2059).

M.—Kasson Brook, Forkston Township, Wyoming County (1000).

N.—Ricketts, Forkston Township, Wyoming County (2100).

O.—2 miles south southwest of Ricketts, Sullivan County (2200).

P.—Kitchen Creek Glen, Fairmount Township, Luzerne County (1200 to 2100).

Q.—2 miles south of Dushore, Sullivan County (2000).

R.—Little Loyalsock Creek, 1 mile south of Dushore, Sullivan County (topographic sheet not yet published—elevation approximately 2000 feet).

S.—Worlds End (Whirl's End), Loyalsock Creek, southeast of Forksville, Sullivan County (1100 to 1500).

Specimens have been deposited in three museums—the Academy of Natural Sciences of Philadelphia (ANSP), the Carnegie Museum of Pittsburgh (CM), and the Toledo Museum of Science, Toledo, Ohio (TMS). I was assisted in collecting by my wife and children.

For assistance in the preparation of this paper I am indebted to Dr. E. R. Dunn, M. Graham Netting, J. T. Sackett, Dr. R. W. Stone, Dr. John M. Fogg, Jr., Harold Trapido, Edmond Malnate and Justine Rawle. Oda Huch was our hostess during our visits to Dutch Mountain. Karl H. Huch, Edith and Oda Behr and Mrs. Otto Behr have been very helpful by supplying considerable information concerning the general area. The late Herman Behr, who lived on the mountain for many years and who was thoroughly conversant with the wildlife of the region, encountered a few species which we failed to collect. According to him, *Thamnophis s. sauritus* was seen occasionally, and *Clemmys insculpta* and *Chelydra s. serpentina* were not rare. He described another turtle (probably *Chrysemys p. picta*) as inhabiting the ponds and lakes. During his lifetime he saw only one lizard on the mountain which, from his description, probably was a *Eumeces fasciatus*. Copperheads, *Agkistrodon m. cupreus*, are unknown in the region, an absence which appears to be prevalent throughout most of glaciated Pennsylvania.

Very probably we might have added one or more of the above species to the following list if we had spent additional time on Dutch Mountain or

visited it at a more propitious season. Owing to circumstances no nocturnal collecting was attempted, either in 1932 or 1940.

List of Species Collected

TRITURUS VIRIDESCENS VIRIDESCENS Rafinesque

Newts were abundant on Dutch Mountain and in its vicinity. Aquatic specimens were found in shallow bodies of water, as in quiet pools along streams, along the shores of ponds and in pasture pools. In one of the last, specimens were extremely common; as many as fifteen could be seen at one time and we had no trouble in catching six in half as many minutes. When pursued they usually moved forward just a few inches and then came to rest on the bottom. Only after two or three attempts to catch them did they move any distance, or make any definite effort to seek shelter under objects in the water. Even then, some individuals concealed only the forward parts of their bodies, leaving their tails protruding and making it easy to see and to catch them. On a cloudy day one specimen was discovered out of the water resting on a lily pad. It dove into the water as soon as it was approached.

Red efts (the land phase) were very numerous also, these being found almost exclusively in or very near woods. Many came to light when logs or stones were overturned, but several were prowling about in the open; some even were crossing roads when found. It was always on cloudy days, however, that they were out. The fact that their skin gland secretions make them distasteful and even poisonous to many potential enemies probably has resulted in newts' being less wary and more venturesome than other salamanders. One large eft was found walking into the Loyalsock Creek, and another was on an old, collapsed bridge over the Mehoopany Creek in a spot it scarcely could have reached without first entering the water.

Specimens collected, 29 (12 aquatic and 17 terrestrial); localities A, C, D, G, J, L, N, O and P; ANSP 22744-64; CM 6248; TMS 477-8.

Five aquatic males range in snout-to-vent length* from 44 to 48 mm. (average 45.6); five females from 40 to 49 mm. (average 45.2). The largest male measures 98 mm. in total length, the largest female 92 mm. The largest terrestrial specimen (a female containing eggs) measures 85 mm. in total length, the smallest juvenile 38 mm.

An eft from Kitchen Creek Glen (ANSP 22762) has the lower jaw deformed, this being directed toward the left, hence failing to meet the upper jaw squarely. The center of the chin is 2 mm. out of line with the center of the upper jaw. This deformity seems not to have interfered with the growth of the animal for it is a large specimen with a total length of 81 mm.

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* This measurement is from the tip of the snout to the posterior angle of the vent. All salamanders mentioned in this paper were measured in the same manner.

DESMOGNATHUS FUSCUS FUSCUS (Rafinesque)

Dusky salamanders were not rare, being collected in three localities. All were beneath stones or logs in very damp or actually wet places. Specifically, they were taken at springs and along the small rills flowing from them, along the edges of rapidly flowing brooks and, in one case, in the water beneath a stone where a fairly strong current was flowing.

The largest single catch of salamanders was made on August 28, 1940, in Kitchen Creek Glen on a cool, drizzly morning following several days of rain. Salamanders seemed to be everywhere, under all manner of objects, and specimens of all the species included in this list were taken at that time except *Eurycea l. longicauda*. Of them all, *Desmognathus f. fuscus* seemed most active, being even more elusive and difficult to capture than *Gyrinophilus*.

On several occasions dusky salamanders were found in identical habitats (sometimes under the same stones) with specimens of *Desmognathus o. ochrophaeus*, but in general it can be said that the present species is much more aquatic than *ochrophaeus*.

Specimens collected, 23; localities H, I, and P; ANSP 22610-26; CM 6237-8.

In each of 10 specimens the costal groove count is 14. Six males range in snout-to-vent length from 36 to 60 mm. (average 51.1); two females are 35 and 41 mm., respectively. The largest male measures 119 mm. in total length, the largest female 84 mm., and the smallest juvenile 34 mm.

The dorsal patterns are very variable. Some specimens are almost uniformly dark above (large males especially) while others are marked with irregular dark streaks or spots on a light grey or brownish background. A few individuals have a middorsal, longitudinal, light stripe but the edges are irregular, lacking the clean-cut appearance of similar middorsal stripes in specimens of *ochrophaeus*. Juveniles bear a double row of light circular spots down their backs.

DESMOGNATHUS OCHROPHAEUS OCHROPHAEUS Cope

This species was by far the most abundant salamander of the region. Specimens were found in a variety of habitats, such as along rills, in and about springs and even in wet woods. In every case, however, the immediate environment was wet or distinctly moist. Not a single specimen was seen in the open (all collecting was done during daylight hours); individuals were found hidden under almost every conceivable type of shelter including stones, logs, boards, leaves, pieces of bark, metal, etc. One very numerous colony was living on the floor of a steep, rocky glen down which water trickled at a rate sufficient to form several small waterfalls. Beneath flat rocks, which received a continuous spray, *ochrophaeus* was very abundant.

Despite its liking for moisture, this species was found in a stream only once and then only a few specimens were taken. Possibly the presence of such

a large enemy as *Gyrinophilus* may help to keep *ochrophaeus* from establishing itself in habitats of this sort. Two individuals were found under a flat rock in company with a large *Gyrinophilus*. A half hour after these were captured the collecting sack was opened for inspection, and the big salamander was discovered with one of the *ochrophaeus* in its mouth!

In general this species occupies a less aquatic habitat than *Desmognathus f. fuscus*, although the two sometimes are found together. While it possibly is of no significance, we found no *fuscus* at elevations higher than 1600 feet, while *ochrophaeus* was abundant at various altitudes from 1100 to 2100 feet.

A large majority of the numerous females collected in 1940 (from August 16 to August 28, inclusive) were examined to determine the condition of their eggs. Specimens with snout-to-vent lengths of 24 mm., or more, contained eggs measuring about 2 mm. in diameter and which, from their size and appearance, seemed almost ready to be laid. Females with snout-to-vent lengths of 26 mm., or less, contained much smaller eggs, probably ones which would have developed the following year. The number of eggs in each female varied from 13 to 24; there were never more than 14 eggs in one oviduct nor less than 6; one specimen had twice as many eggs in one oviduct as in the other (14 and 7).

Specimens collected, 171; localities A, B, G, H, I, P and S; ANSP 22627-35, 22636 (27 specimens), 22637-46, 22647 (15 specimens), 22648 (59 specimens); CM 6239-40, 6244; TMS 481-6, 497-511.

In 20 specimens the costal groove count is 14, except in one male which has only 13 on one side. Eight males range in snout-to-vent length from 40 to 54 mm. (average 44.6); eight females from 36 to 45 mm. (average 39.6). The largest male (with perfect tail) measures 101 mm. in total length, the largest female 85 mm., and the smallest juvenile 29 mm.

The light dorsal band, characteristic of this species, is present in every specimen collected, although it can be made out only with difficulty in the largest males. In the latter, there is a general darkening and obscuring of markings to the point where the dorsal surface is almost uniformly dark. The band is conspicuous in all other individuals, especially in juveniles. In some (in life) it is light grey, in others cream, yellow, orange, brown or chocolate. Some of the yellowish specimens bear a superficial resemblance to *Eurycea b. bislineata*. The number of V-shaped or round, dark spots forming a row down the center of the back varies from zero, in some specimens, to twenty or more in others. In general, it appeared that the paler, more brightly colored specimens were found in the greatest abundance in the least wet habitats, but no detailed notes were kept on this point.

PLETHODON CINEREUS (Green)

Only a few salamanders of this species were found. Of the four collected in 1932, all were red-backed, and all were taken on successive days (September 24 and 25) in the same locality. In 1940, five were obtained on August

28, four red-backed and one of the dark phase. Every specimen was hidden from sight—in old lumber piles, under boards, pieces of metal and birch logs. All were in or near woods, one being taken in the midst of a few acres of virgin hemlock forest. It had rained or was raining when all were collected.

Specimens collected, 9; localities A and P; ANSP 22679-83; CM 6245; TMS 513-5.

In 9 specimens the costal groove count is 18 in 1, 19 in 6, 20 in 1, and 20 on one side and 19 on the other in 1. Three males range in snout-to-vent length from 34 to 40 mm. (average 37.3); six females from 35 to 46 mm. (average 40.5). The largest male measures 79 mm. in total length, the largest female also measures 79 mm.

PLETHODON GLUTINOSUS (Green)

Slimy salamanders were found only in the woods along Kitchen Creek (locality P) and only in 1940. There, in a single morning (August 28) seven specimens were obtained (ANSP 22684-90), all but one of which were in or under rotten logs; the exception, the largest individual, was under a rock. The day was cool and drizzly, and specimens were quite active in their attempts to escape, burrowing down into the rotten wood of their hiding places with considerable speed and making full use of their glue-like skin gland secretions when they were seized.

In the 7 specimens the costal groove count is 15 in 6 and 14 in 1. Three males range in snout-to-vent length from 62 to 78 mm. (average 68.3); three females 71 to 78 mm. (average 75.3). The largest male (with perfect tail) measures 139 mm. in total length and the largest female 172 mm.

GYRINOPHILUS PORPHYRITICUS PORPHYRITICUS (Green)

Purple salamanders were found only in and along the edges of streams; all were under stones except one which was collected by a garter snake (see page 169)! Sometimes they were in the water itself, occasionally completely submerged, but more often they were in damp spots at the edges of the streams. A number were found under flat stones beneath the waterfalls along Kitchen Creek. *Desmognathus f. fuscus* was the only other salamander of the region which might be said to occupy habitats identical with many of those utilized by *Gyrinophilus*.

Specimens collected, 28; localities B, G, I and P; ANSP 22659-61, 22662 (12 specimens); CM 6235; TMS 524-32.

In 12 specimens the costal groove count is 17 in 7, 18 in 2, and 17 on one side and 18 on the other in 3. Five males range in snout-to-vent length from 72 to 99 mm. (average 87.6); seven females from 73 to 99 mm. (average 85.9). A juvenile, with a snout-to-vent length of 64 mm., has slight traces of gills. A larva, 34 mm. in length, exclusive of the tail, was collected in a small stream trickling from a spring high up on the mountainside.

EURYCEA BISLINEATA BISLINEATA (Green)

This species proved to be common in several localities and in one it was really abundant. The latter was along the polluted Loyalsock Creek where an even dozen were uncovered in less than an hour, these being beneath stones and boards along the creek. In other localities specimens were discovered under pieces of bark, boards and rocks, and several were taken, each under a large rock a hundred yards or more from the nearest visible body of water. Indeed, except for *Plethodon cinereus* and terrestrial examples of *Triturus*, two-lined salamanders were found farther from water than any other salamanders of the region. However, individuals were in such places only during or after rains.

Specimens collected, 30; localities A, G, I, P and R; ANSP 22652 (12 specimens), 22653-6, 22657 (9 specimens); CM 6236, 6250; TMS 479, 550.

In 10 specimens the costal groove count is 15. Five males range in snout-to-vent length from 36 to 40 mm. (average 37.8); three females from 28 to 37 mm. (average 32.7). The largest male measures 90 mm. in total length, the largest female 82 mm., and the smallest juvenile 43 mm.

EURYCEA LONGICAUDA LONGICAUDA (Green)

Long-tailed salamanders were found only on one day (August 20, 1940) and in only one locality (R), this being along the Little Loyalsock Creek. The water in this stream, while clear, had a very unpleasant odor and the shores were littered with various kinds of debris, from abandoned automobiles to garbage. Under stones and boards at the edge of the creek a dozen specimens were found (ANSP 22658)—exactly the same number and in exactly the same habitat as specimens of *Eurycea b. bislineata* which were taken at the same time.

In 6 specimens the costal groove count is 13 in 3, 14 in 1, and 13 on one side and 14 on the other in 2. Three males range in snout-to-vent length from 43 to 46 mm. (average 44.7); in a female this measurement is 56 mm. The largest male measured 108 mm. in total length, the largest female 138 mm., and the smallest juvenile 49 mm.

BUFO AMERICANUS AMERICANUS Holbrook

Toads were fairly common, although most of those obtained were very small, being young of the year. All were hopping in woods or along the banks of streams. It is of interest to note that every specimen found was out in the open, a statement which holds true for almost every tailless amphibian we encountered in the region. In other areas, numerous individuals normally can be found during the process of overturning rocks and boards, but frogs and toads were singularly lacking in such hiding places, and instead were much in evidence in the open.

Specimens collected, 15; localities A, B, E, G, I, P and S; ANSP 22605-9; CM 6241, 6246, 6252; TMS 480, 523.

A large adult (♂) has a snout-to-vent length of 75 mm. and a tibia length of 32 mm. The snout-to-vent length of each of several small toads collected falls between 17 and 21 mm.

HYLA CRUCIFER CRUCIFER Wied

In most areas where I have done considerable collecting, and where field work has been extensive at all seasons of the year, it has been quite unusual to collect spring peepers except during the breeding season in early spring. This certainly is not true in the mountainous parts of eastern Pennsylvania; eight were obtained on Dutch Mountain, one in 1932 and seven in 1940. Similar success also has been achieved in summer and early fall in the Pocono Mountains of Monroe County, Pa. Some of the individuals collected were hopping about in the rain, but others were taken on clear, warm days, even during the dry weather prevailing in the early part of the 1940 trip. All were in moist woods, however, and a possible explanation of their appearance "out of season" may be in the humid conditions which prevail in the forested mountains.

Specimens collected, 8; localities A and B; ANSP 22663-5; TMS 554. The largest specimen, a female, has a snout-to-vent length of 29 mm. and a tibia length of 13 mm. The snout-to-vent lengths of several juveniles are from 16 to 19 mm.

RANA CATESBEIANA Shaw

A young male bullfrog (ANSP 22690) was collected July 6, 1941, by my son, Roger Karl Conant, during a brief visit to Dutch Mountain. This specimen, which has a snout-to-vent length of 73 mm. and a tibia length of 36 mm., was found in a small pool of water at locality A.

RANA CLAMITANS Latreille

Green frogs were obtained in moist woods, along streams, near springs, in wet meadows, etc. Those along the streams usually were resting at the edges or upon stones in midstream. Specimens which eluded capture by diving in the water, and swimming first under one shelter and then another, become noticeably more sluggish the longer they remained submerged in the cold water.

Specimens collected, 30; localities A, C, D, G, H, J and P; ANSP 22691-700; CM 6242, 6249, 6253; TMS 533-49.

Three large females range in snout-to-vent length from 80 to 83 mm., and in tibia length from 42 to 44 mm. No large males were collected. The snout-to-vent length of the smallest specimen is 33 mm.

RANA PALUSTRIS LeConte

This was the most abundant frog in the area. Individuals were found in a variety of habitats—along streams, in springs, ponds and lakes, in moist woods, and even in meadows high up on the summit of the mountain. Many were found in the midst of a large hay field of several acres' extent. With

only one exception, however, all large specimens actually were in or very near permanent bodies of water. Small, newly transformed, individuals were the only ones found in the open fields, but there they were very numerous, it being not unusual to see a score or more in the course of walking a few hundred yards.

There was considerable evidence to indicate that final transformation from tadpole to frog occurred during the last two weeks of August (1940). Numerous specimens, still bearing tails, and with heads and mouth parts still resembling those of tadpoles, were found hopping about at the edge of a pasture pool. The tails of some of these were as much as 14 mm. in length; the snout-to-vent lengths of such frogs varied from 23 to 26 mm. Small, fully transformed individuals had snout-to-vent lengths of from 25 to 33 mm.

In two large females the snout-to-vent length is 80 and 66 mm. and the tibia length is 44 and 39 mm., respectively. The corresponding measurements, in the only large male collected, are 61 and 36 mm.

Specimens collected, 43; localities A, B, D, F, G, P and R; ANSP 22701-11, 22712 (2 specimens), 22713-9, 22765; CM 6243, 6247, 6251; TMS 478-90, 491-6, 512, 516-22.

RANA PIPIENS Schreber

This species was obtained in only one locality—along the Little Loyalsock Creek, near Dushore (locality R) on August 17 and 20, 1940. A total of five specimens (ANSP 22720-4) was secured, all being taken in grassy spots along the stream. All were about the same size; in four males the snout-to-vent lengths are 50, 51, 52 and 55 mm., and the tibia lengths 28, 30, 31 and 31 mm., respectively; in the single female the corresponding measurements are 51 and 28 mm., respectively.

RANA SYLVATICA SYLVATICA LeConte

No wood frogs were found in 1932, but several were caught in 1940. All were hopping about in moist woods, except two taken in grassy spots along the Little Loyalsock Creek, in the midst of open farming country. Many of those secured were very small, probably young of the year. These measure 20 to 27 mm. in snout-to-vent lengths; the largest specimen has a snout-to-vent length of 36 mm. and a tibia length of 22 mm.

Specimens collected, 7; localities A, P and R; ANSP 22725-31.

DIADOPHIS PUNCTATUS EDWARDSII (Merrem)

Of ring-necked snakes, we found only four and a clutch of eggs; we missed this species entirely during the 1932 trip. All were obtained under rocks, except one which had been run over on the road. Each of those taken on Dutch Mountain was beneath a rock at the edge of a dirt road. Such rocks proved profitable to overturn; presumably snakes, after crossing the open roads, are apt to take shelter under the first suitable objects they encounter. At least, our success in finding snakes was much more marked when we

hunted along the margins of dirt roads than it was when we overturned things in fields and woods.

A specimen collected at Worlds End was discovered while we were pursuing a garter snake, which retreated into a pile of loose stones at the base of a cliff. While hastily tossing the stones aside to expose the quarry, a ring-necked snake was uncovered, but only briefly, for it too streaked down into the pile. It had crawled beneath several layers of stones before our frenzied efforts enabled us to get down to it. One of the specimens taken on Dutch Mountain also moved off instantly when its shelter was removed from above it. It attempted to take refuge in an insect burrow that communicated with its retreat.

Three eggs of this species were found (August 20, 1940) lying on the ground at the upper end of a small slab of rock, which rested on the steeply sloping bank at the side of a dirt road. One egg was shrivelled and partially desiccated but contained a well-formed embryo 86 mm. in length, and immediately identifiable as *Diadophis*. The other two eggs, both in good condition, were bent in crescent shape. In fact, they resembled cashew nuts, in both size and appearance. When found, one of the eggs measured 20.0 x 9.3 mm. (9.6 mm. across the hump of the crescent), and the other measured 26.9 x 9.0 mm. The eggs were placed in rotting wood and were later transported to Philadelphia. On September 1 they were measured again, and weighed, with the following results: 29.7 x 9.4 mm. (10 mm. across the hump), 1.7 grams; 27.0 x 9.4 mm., 1.2 grams.

Both eggs hatched September 14. Each young weighed exactly one gram; one was 121 mm. long (tail 28 mm.), the other was 111 mm. (tail 23 mm.). They were dull blue-black above with whitish-yellow neck rings; the bellies were unmarked and were flesh-colored, with a slightly orange tone. Both young shed September 22 and immediately appeared much brighter, changing to deep blue-black above, and bright yellow below.

Specimens collected, 7 (2 hatched from eggs); localities A, G, L and S; ANSP 22649-51, 22771-2.

Specimens studied, 5 (2 ♂, 1 ♀, 2 juveniles—both ♀). All have 15 rows of scales throughout, except one juvenile which has 13 for a short distance anteriorly. Upper labials 7 in 3 specimens, and 8 in 2; lower labials 8 (7 on one side in one individual). Oculars 2-2; temporals 1-1 in all adults, 0-1 and 1, 0-1 in the juveniles. Ventrals in adult males 152 and 153, in the female 164, in the juveniles 149 and 154. Subcaudals 51 and 56 in the males, 48 in the female, 50 and 60 in the juveniles. Relative tail length* in males .217 and .227, in the female .188, in the juveniles .207 and .231. The larger male measures 300 mm. in total length, the female 292 mm.

The adults, in life, were light steel blue above, although one had a distinctly

* This figure is obtained by dividing the length of the tail by the total length of the snake.

brownish tinge. None has dark midventral spots, and only one shows a slight tendency toward interruption of the neck ring.

OPHEODRYS VERNALIS VERNALIS (Harlan)

Three green snakes were collected in 1932 and six in 1940. Of these nine, two were dead on the road and another was accidentally run over. Two were in hiding—one under a small log at the edge of a beaver dam, the other under a rock beside a dirt road. All the others were out in the open, crawling in the grass or along paths, and most of them made off with considerable speed when they were approached. One, lying in the sunshine on a paved highway, however, did not move when a car passed over it, nor did it attempt to escape until picked up. Its only movement, as the collector walked up to it, was to thrust out its tongue several times.

A clutch of five eggs was found August 19, 1940, under a board at the edge of the Santee Creek. The eggs all looked puffy and flabby and, judging from their suroundings, they appeared to have been under water recently. In any event, they seemed much too moist and the ground beneath them was quite wet. Three were adherent to one another, the other two were each separate; the underside of each was stained brown from contact with the earth. When found, the eggs measured: 36.0 x 11.5 mm., 36.9 x 10.4, 33.8 x 10.0, 33.3 x 11.2, and 34.9 x 11.4.

These eggs also were placed in decaying wood and taken to Philadelphia. On September 1 their weights and measurements were:

37.5 × 12.3 mm.; 3.1 g.
37.7 x 11.3 mm.; 3.1 g.

34.9 × 12.2 mm.
34.0 × 11.5 mm. } 9.2 g. (all adherent)
35.9 × 12.3 mm.

At this time the eggs looked normal and healthy. They were well filled out and were sub-cylindrical in shape.

The eggs were discovered hatching during the early evening of September 11, at which time four young ones already had escaped from their shells. The fifth egg was collapsed and wet, and the inmate was moving about endeavoring to locate one of the two slits it had made in the shell. Eventually it found one of them and thrust out its entire head. It held this position for a second or two, and then crawled out of the egg, leaving only its tail inside. There it lay, stretched out in a straight line for six minutes, remaining motionless, except to open its mouth wide three times as though gasping for air. At the end of six minutes it shifted its position slightly and then remained motionless again. At the end of ten minutes its body was dry, and at eleven minutes, it protruded its tongue for the first time and started crawling about, incidentally pulling its tail out of the egg.

Measurements and weights of the young upon hatching were:

Weight	Total Length	Tail Length
1.2	123	39
1.2	124	39
1.2	128	40
1.2	123	40
1.2	125	40

When hatched, the young were dark greenish grey in coloration. One shed on September 19, and the others on September 20, their new skins being slightly lighter in color than the old. It was not until more than a month later that they resembled adult green snakes in coloration.

The data on the eggs and young, given herewith, agree with those published by Blanchard (1933) except in two respects. He gives the maximum length of green snake eggs from northern Michigan as 34.0 mm., a figure which was exceeded by all but two of the eggs from Dutch Mountain. Most of Blanchard's eggs were measured when laid, however, which mine were not, and the fact that eggs increase in size and weight before hatching may well account for the discrepancy. He gives September 4 as the latest hatching date, a full week earlier than the date noted above. A number of factors might account for the difference, including locality, elevation, season and the fact that the eggs we found may have been subjected to at least a temporary soaking.

Specimens collected, 14 (5 hatched from eggs); localities A, B, G, K, L, M and O; ANSP 22675-8, 22766-70; TMS 1595, 1608-9.

Specimens studied, 12 (6 ♂, 1 ♀, 5 juveniles—4 ♂, 1 ♀). All have 15 rows of scales throughout. Upper labials 7; lower labials usually 8, but 7 on one side in each of two specimens, and 9 on one side in each of two other specimens. There are many irregularities involving the scales in front of the eye. Normally there are a single nasal, single loreal and single preocular. However, one adult and one juvenile each have two preoculars, on each side of the head, and another juvenile has two on one side and one on the other. In two adults, each nasal and its corresponding loreal are fused into one scale, and this condition also occurs on one side of the head in one of the juveniles. Another juvenile has the loreal, on one side of the head, split into two small scales, one above the other. Postoculars, 2 in every case; temporals 1-2, except that one adult and one juvenile each have a single scale in the second row on one side of the head. Ventrals in males 120 to 125, average 122.5; female 136; juvenile males 118 to 122, average 120.3; juvenile female 130. Subcaudals in males 83 to 89, average 85.4; female 72; juvenile males 77 to 83, average 79; juvenile female 70. Relative tail length in males .329 to .352, average .341; female .306; juvenile males .304 to .311, average .306; juvenile female .267. The largest male measures 457 mm. in total length, the adult female 468 mm.

COLUBER CONSTRICTOR CONSTRICTOR Linné

Only one snake of this species was seen, and it was a crushed and decayed specimen about 1200 mm. in length, found August 20, 1940, lying on the highway about two miles south of Dushore (locality Q).

ELAPHE OBSOLETA OBSOLETA (Say)

A very large, decomposed specimen, cut in pieces and obviously the victim of a human being, was found August 20, 1940, on the dirt road on the side of the mountain near where it crosses Becker Brook (locality G).

According to residents, "black" snakes are not very common in the Dutch Mountain region although they are said to be found occasionally in the Mehoopany Valley. Whether or not they belong to this species, only additional collecting will determine. The heavily forested nature of the valley, however, would seem to be a better habitat for *Elaphe* than for *Coluber*.

LAMPROPELTIS TRIANGULUM TRIANGULUM (Lacépède)

Two milk snakes were collected, a live juvenile under a large stone at the edge of a dirt road, and a small, fragmentary specimen—head and neck only—in the ditch beside a freshly tarred road. Milk snakes, reputedly not rare, probably are one of the most important enemies of the numerous small snakes of the region; the live specimen disgorged the unidentifiable remains of a snake's tail.

The single specimen preserved (locality A; ANSP 22666) is a small female measuring 259 mm. in length. It has a scale row formula of 21-19; ventrals 194; subcaudals 44; oculars 1-2; temporals 2-3; upper labials 7; lower labials, 8 on the left, and 9 on the right; relative tail length .135. There are 34 dorsal body blotches, and 10 blotches on the tail. The large, middorsal blotches extend downward to the fourth row of scales.

NATRIX SIPEDON SIPEDON (Linné)

The few water snakes collected indicate either, (1) that they are more common along streams bordered by open fields than they are along streams bordered by woods, or (2) that they are easier to find in the more open type of habitat. Probably the second supposition is the more true, for the numerous rocks along the banks of open streams constitute the best, and sometimes the only, shelters under which the snakes can take refuge. The dense woods, which flank the majority of streams in the region, furnish innumerable hiding places, most of which are inaccessible to the collector. By systematically overturning rocks along the Little Loyalsock Creek (locality R), where it passes through farming country, seven specimens were secured. Only three were found elsewhere, two under flat stones along forested streams, and the other trapped and flattened on a freshly tarred road near a creek.

Specimens collected, 10; localities A, J, P and R; ANSP 22667-74; TMS 1599.

Specimens studied, 9 (4 ♂, 5 ♀). All have a maximum of 23 scale rows; four have a minimum of 17, and five a minimum of 16. Labials 8-10; oculars 1-3; temporals 1-2 in most cases, 1-3 in others. All variations (above) occur as frequently in one sex as in the other. Ventrals in males 139 to 143, average 141.8; in females 141 to 147, average 143.2. Subcaudals in males 74

to 77, average 75.3; in females 62 to 65, average 63.8. Relative tail length in males .259 to .266, average .262; in females .221 to .233, average .227. All specimens collected were sub-adults. Largest male 428 mm., smallest 290 mm.; largest female 519 mm., smallest 267 mm. The tails are incomplete in the largest specimen of each sex. The number of dorsal body blotches varies from 31 to 40, the number in males averaging slightly higher than in females.

STORERIA OCCIPITOMACULATA (Storer)

Of all the amphibians and reptiles collected, this is the only species secured in greater numbers during 1932 than on the longer trip in 1940. Nine were taken the former year and three the latter. All, without exception, were found hidden beneath such objects as boards, logs, tar paper and the door of an abandoned automobile. They were in fields, pastures and at the edges of dirt roads.

A female, 258 mm. in length, collected August 10, 1940, contained three dry, hardened, infertile embryos. All other females apparently had given birth to their young of the year.

Specimens collected, 12; localities A, F, J, L and O; ANSP 22732-4; CM 6257; TMS 1596-8, 1600-3, 1607.

Specimens studied, 12 (3 ♂, 8 ♀, 1 juvenile—♂). All have 15 scale rows throughout. Upper labials 6; lower labials 7 (6 on one side in each of two specimens). Oculars 2-2 (a single postocular on one side in two). Temporals usually 1-2, 1-1 in one specimen, and 1-3 in three instances. Ventrals in males 113 to 121, average 116.5; in females 117 to 125, average 121.9. Subcaudals in males 45 to 47, average 46; in females 37 to 43, average 41.3. Relative tail length in males .216 to .234, average .226; in females .192 to .225, average .211. The juvenile, which is 140 mm. in length, exhibits no departures from the normal, except for a large scarred area on the abdomen, and therefore it is included in the summaries above. The adults are remarkably uniform in length, males varying from 235 to 264, average 245.7 mm., and females from 217 to 262, average 242 mm. The tail is complete in every specimen.

THAMNOPHIS SIRTALIS SIRTALIS (Linné)

Eleven garter snakes were obtained in 1932 and twelve in 1940. About half those collected were found under logs, rocks, etc. Several, however, were prowling about in the open, two were sunning themselves on roads and three, at Worlds End, were sunning on a mass of broken rocks at the foot of a cliff. At least two were prowling about on cool days. One of the latter was at Rouse Pond, where it was found a few inches above the shore line in the midst of a pile of tin cans and broken bottles.A heavy drizzle was falling, there was a strong, cold wind and the temperature was about 60 degrees; the snake felt distinctly cold to the touch. This was about the "rawest" day on which I ever recall having seen a snake out in the open.

The other specimens, abroad on a cool day, was crawling sluggishly along

the edge of Stony Brook. The weather was clear but the temperature was only about 64 degrees. The snake easily was caught, and since it was quite obvious that it had eaten recently, I pressed against its abdomen and forced it to disgorge. Out came a large, live *Gyrinophilus p. porphyriticus* head first. When about half of its body was free, the salamander turned, opened its mouth and bit the snake on the neck. As soon as the amphibian was fully ejected, the snake turned and bit its adversary at about midbody. When they were forcibly separated the salamander attacked again, and as the snake sought to strike back, the two locked jaws! The salamander's tail was partially missing and the remnant bore scratches, indicating that the snake probably seized it by that member first. It would have been interesting to have seen the garter snake swallow such a large, belligerent meal.

Most of the specimens collected were in "open" habitats. Only three were found in woods, and two of these were along streams, the other was lying in the water at the edge of the marshy overflow from a spring. Degree of relative dryness seemed to have little effect on these snakes. Besides occurring in the above mentioned habitats, two were in a marshy meadow, while several others were found in dry spots under boards in the midst of open fields high on the mountain.

A large female, caught August 15, 1940, passed two infertile ova September 20, two premature young September 21, and one live young on September 22. The live juvenile measured 148 mm. in length; the parent 608 mm. The abnormal birth possibly was due to injury during capture or transportation. Five additional well-formed embryos were found in the female after it was preserved.

A female collected and preserved August 18, 1940, and measuring 485 mm. in length, contained six perfectly developed young averaging 145 mm. in length. All other breeding females appeared to have had their young of the year prior to capture. Most contained very small eggs, evidently those which would have developed the following year.

Specimens collected, 23 (plus one born in captivity); localities A, D, F, G, I, L, P and S; ANSP 22735-43; CM 6256; TMS 1591-4, 1604-5.

Specimens studied, 17 (5 ♂, 11 ♀, 1 juvenile—♀). The scale row formula is 19-17 in all. Upper labials 7 (8 on one side in three individuals); lower labials usually 10 (11 in one, 9 in four instances, and 8 on one side in one specimen). Oculars 1-3, 4 on one side in one specimen. Temporals usually 1-2 but frequently 1-3. Ventrals in males 145 to 151, average 148.6; in females 133 to 149, average 141.6. Subcaudals in males 64 to 68, average 66.2; in females 55 to 62, average 59.3. Relative tail length in males .231 to .245, average .236; in females .194 to .224, average .215. The single juvenile is normal in every respect and is included in the summaries above. The largest male measures 498 mm. in total length, the largest female 608 mm. Every individual in the series has a perfect tail.

In all these specimens the dark spots between the stripes are quite prominent, and there is a strong tendency in many of them for the spots of the

upper row to extend upward, meeting their partners of the opposite side. Thus they are marked with a series of narrow, dark crossbands across the light middorsal stripe, a condition which suggests the normal type of pattern in some of the western garter snakes, notably *Thamnophis ordinoides vagrans*. In general the ground color in all the specimens collected was (in life) olive or greenish, the stripes bearing a bluish tinge and the dorsal spots being chestnut, dark brown or black.

CROTALUS HORRIDUS HORRIDUS Linné

Judging from reports, rattlesnakes are not rare on Dutch Mountain, at least on the southeastern slope facing the Mehoopany Creek. One was killed by a resident during our 1940 visit, but the remains had been disposed of by the time the report was traced. Although a special point was made to work in areas where rattlers were supposed to be most common, we failed to find any. Two specimens, preserved about 40 years ago by the late Otto Behr, still are in existence at his home, and through the courtesy of members of his family permission was granted to study them. Scale counts obtained from these two snakes are listed below:

Sex	Scale Rows	Ventrals	Subcaudals	Labials	Approximate Total Length
♂	25-23-19	170	21 (4 divided)	14-16,15	950 mm.
♀	25-23-19	168	19 (2 divided)	15-14	1080 mm.

The male is dark yellowish-brown with about 22 very dark crossbands. The top of its head is yellow and the tail is nearly uniform black. The female is black with the markings quite indistinct. Both the top of its head and the tail are black.

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ZOOLOGICAL SOCIETY OF PHILADELPHIA,
PHILADELPHIA, PA.

Utilization of Rock Exposures for Den and Escape Cover by Raccoons[1]

LeRoy W. Giles[2]

The raccoon *(Procyon lotor)* is generally considered to be a tree-denning animal, and throughout most of its range this seems to be the natural condition. Seton (1929) describes the ideal raccoon den as "some hollow branch high up in a large tree," while Scott (1937), Bennitt and Nagel (1937) and others associate a general decline of the raccoon population with the destruction of hollow trees. In the absence of den trees raccoons are known to resort to ground dens. In central Iowa drainage tiles are frequently found in use as substitute dens, and the ground burrows of other animals often serve as temporary retreats.

In eastern Iowa, however, it was learned that the raccoons were denning in limestone bluffs and apparently giving preference to this type of den to the customary hollow tree. The use of rock dens which has been mentioned occasionally in the literature (Stone and Cram, 1904; Whitney, 1931; Hamilton, 1939; and others), may be quite important where such an environment is to be found. This type of habitat was studied in connection with research in the ecology of the raccoon in Dubuque County, Iowa. Observations were made throughout an area of approximately 21 square miles which was located about 3.5 miles west of the Mississippi River. The area is drained by several small branches of the Little Maquoketa River. Along these streams and their narrow tributaries were many prominent limestone outcrops varying in size from small ledges to relatively large cliffs. Some of the largest of these were 600 feet or more in length and as high as 75 feet in places. These rock exposures were much broken by cracks and fissures in which the raccoons made their dens. They furnished more than a sufficient number of den sites as well as escape cover, and were utilized not only by raccoons but also by foxes *(Vulpes regalis* and *Urocyon cinereoargenteus)*, skunks *(Mephitis mephitis)*, opossums *(Didelphis virginiana)*, woodchucks *(Marmota monax)*, and rabbits *(Silvilagus floridanus)*. Hollow trees, which are not uncommon, have been forsaken by the raccoons for rock shelter apparently just as suitable and much more abundant.

The investigation covered a period of 9 months in 1938 and was continued on occasional visits to the area in 1939 and 1940.

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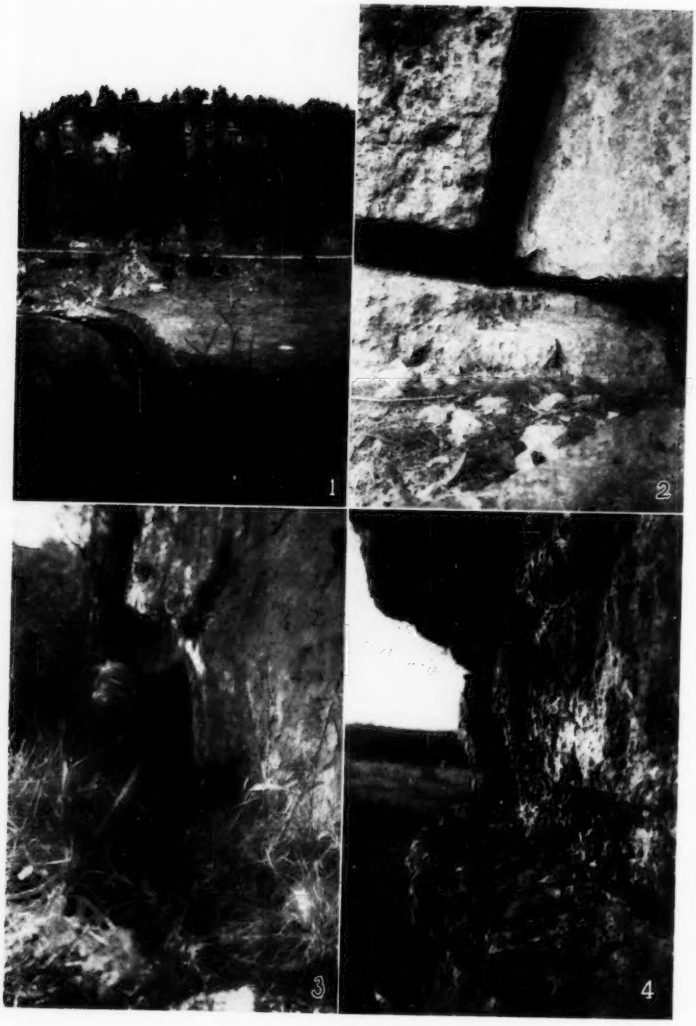
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The valley bottoms and flattened hilltops of the region are pastured or cultivated while the hillsides, for the most part, are in timber. Consequently, as the bluffs are surrounded by woods, the raccoons remain in contact with their habitual cover. The trees on the hills are principally oaks *(Quercus)*, with some hickory *(Carya ovata)*, walnut *(Juglans nigra)*, and maple *(Acer saccharum)* on the north slopes. On the talus slopes and in the vicinity of the streams are soft-woods such as elm *(Ulmus)*, basswood *(Tilia americana)*, box elder *(Acer negundo)*, and willow *(Salix)*. Cedars *(Juniperus virginiana)* are quite numerous on the drier exposures and grow on the ledges and along the tops of the bluffs.

The rocks of the region, also provide a certain amount of artificial shelter which is readily accepted for denning. Originally the underlying limestone had lead-bearing strata, which in former years had been extensively mined. These old excavations, long since abandoned, now serve as homes for various mammals.

The outcroppings of rock in the area are not evenly distributed. While bluffs are common features of the physiography of the eastern end their presence in the western part is limited and localized. In the latter direction the terrain begins to assume the flatness of the prairie country lying farther west and instead of being rough and hilly has more of a rolling character. Bluffs here are not only fewer but of smaller size. This variation in the environment was definitely reflected in the distribution of the raccoon population. A census taken in 1938 revealed that the proportion of raccoons in the eastern part of the area to those in the western part was approximately 3 to 1.

In order to obtain an idea of the actual use of this type of den habitat a section along one of the streams in the central part of the area, two miles long and one-half mile wide, was selected for more intensive study. This section included two miles of rock exposure. In this exposure 11 dens were used by raccoons either temporarily or permanently during the time of the investigation. Besides these a count of the dens of other fur-bearers and all cracks and holes which appeared usable was made to determine not only the number of available dens but also the amount of potential escape cover. There was found to be an average of one usable, or apparently usable, aperture for every 25 yards of bluff.

Fig. 1. A typical view on the area, taken in April. The abundance of cedars about the bluff is readily apparent.

Fig. 2. A large fissure extending both vertically and horizontally. At the opening the vertical crack is about one foot wide. This particular den was used only temporarily.

Fig. 3. A den opening on a ledge near the top of a high bluff. The path leading to the entrance was formed by a raccoon. Beside the hole is the trunk of a small cedar tree.

Fig. 4. A narrow ledge on a high bluff leading to a den.

These frequent openings in the rocks, providing they were not too shallow, often served as concealment for hunted animals. On many an occasion a hunter's dogs would end their chase, in futility, at the base of some sheltering bluff, or if the pursuit happened to start near a ledge, the raccoon would almost certainly escape into some convenient hole. In an environment of this nature the amount of effective shelter available for hasty refuge is many times greater than that of a wooded area alone.

In the entire area 42 dens were discovered. Five of these were in abandoned mines, while the remaining 37 were in rock bluffs. Th raccoons gained access to the bluff dens by means of crack of various sizes. These cracks were vertical in position, though in two cases the entrances were situated under tilted slabs which formed horizontal recesses. In both instances, however, the recesses were shallow and were connected directly with vertical cracks. The height of the vertical fissures varied considerably. In some cases the crack penetrated only a single thin stratum which was underlain and capped by solid rock so that the opening was small (Fig. 5). In other cases the entire face of the bluff was split. The largest crack of this nature which was known to form the entrance to a den was 40 feet high and varied from 2 to 4 feet in width. It gradually became narrower as it extended back into the rock, and it was choked with loose rock so that it actually consisted of a maze of small passages. This particular den was in use each year of the investigation and had a reputation of long standing among local sportsmen. One unusual den entrance consisted of a small hole opening on a ledge at the base of a very narrow crack which extended to the top of a bluff (Fig. 3).

About half of the dens opened in more or less inaccessible places on the steep, precipitous faces of the larger bluffs (Fig. 4). The raccoons seemed to show a preference for these sites. In general the rocks of the larger bluffs were more compact, less broken and split, than those of the smaller exposures and consequently offered fewer dens. Hence, even though the number of dens was about the same in both situations, the den cover in the larger bluffs was more fully utilized. Also dens in the larger bluffs were used more consistently. A number of the dens in the smaller bluffs showed indications of only temporary use.

Several indicators were used in establishing the presence and location of the dens. An abundance of scats on the ledges and on top of any of the bluffs was usually sufficient evidence to denote the presence of a den. The raccoons spent considerable time climbing and wandering about the rocks, and as a result their fecal passages were commonly found in these places (Giles, 1940). The number of scats was generally the greatest in the immediate vicinity of the dens and occasionally latrines of considerable size were formed near the entrances. Hairs or tracks in the dust, which was often present in the cracks, were indicative of denning. In places where grass grew on the ledges near the entrances definite trails or paths were formed by the continual passage of the animals, and sometimes on the very edge of the ledges or rim rock overlooking the valley below "forms" were found in the vegetation where the raccoons

had repeatedly bedded down for resting. In a few instances materials such as dust or flour were sprinkled at the mouth of cracks of questionable status in order to obtain track records.

The use of mines as dens was easily ascertained. Their tunnels were thickly carpeted with dust which would be packed with tracks; moreover, the tunnels yielded numerous scats. These mines apparently made excellent dens. In general they conissted of a labyrinth of small tunnels just large enough for a man to crawl through with occasional larger cavities where ore had been removed. Many of the passages were partially filled with rock — debris dumped there from further excavations started in other directions when the former had proved unproductive.

Fig. 5. A den located in a small crack occurring in a single layer of rock.

Nothing very definite can be said about the number of entrances to most of the dens. The broken character of much of the outcropping rock often permitted entrance or exit at several, sometimes widely separated, places. Woodchucks occasionally created still other entrances by digging burrows leading to underground fissures or the mine tunnels. The den in the large, rock-filled crack, already described, is an example of one with many entrances. The den illustrated in Fig. 5 had two known entrances. Dens with only one entrance seemed to be in the minority. The den in Fig. 3 apparently had only one. Where numerous entrances were present the raccoons had a habit of using only one or two in preference to the others.

Dens were most commonly found in those bluffs nearest the stream, though a few dens were found near drainage lines which were dry except after heavy rainfall. One such den was located in a bluff 600 yards from the nearest stream. This is the greatest distance that any den was found from permanent water. The average distance of dens from water was 154.5 yards with two-thirds of the dens located within this distance.

In one den the "nest chamber" was accessible for examination. The chamber was located near the face of a bluff in a small crack which was shielded by a

wall of loose rock fragments. The outside entrance to the den was in another crack only a few feet away. The den cavity was several feet high, and from 6 to 8 inches wide at the bottom, becoming narrower at the top. The nest was in a shallow depression in the dust which coated the bottom of the crack and was lined with grass mixed with a few leaves and the winged portions of basswood fruits. In the lining and in the dust underneath were bits of insect chitin and other materials from disintegrated feces. It seems highly improbable that the nest had actually been lined by a raccoon. It is much more likely that the nest was of woodchuck origin and had simply been appropriated by the raccoon. Two other woodchuck nests of very similar construction and location were examined during the investigation.

An abundance of available dens in this region is one of the most important factors influencing the annual production of a considerable number of raccoons. The maintenance of a high population reflects the adequacy of the environment, for the raccoons are subject to an extremely heavy hunting pressure. The area is near the city of Dubuque which has a large group of active sportsmen, and in addition, it attracts many hunters from surrounding localities. During the hunting season of 1938-39 a total of 58 raccoons was reported as killed. This is an average of 2.76 raccoons to a square mile for the area as a whole. If the uneven distribution of the raccoon population is taken into consideration, however, the kill was probably somewhat greater than 4 to a square mile in the eastern part and less than half of that in the western end.

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Distribution of Stream Plankton in the Ohio River System*

Floyd J. Brinley and Leonard J. Katzin

The plankton organisms of streams of the Ohio basin have not received as much attention as have those of still waters. The algal and protozoan members of the plankton of the Scioto River and a few other streams have been listed by Lackey (1938, 1939) and Lackey and Smith (1940). Some data are also available on the Ohio River (Purdy, 1923), Hocking River (Hutchison, 1939 and Roach, 1932), White River (Denham, 1938) and other streams, but these lists are restricted in scope.

In the course of a biological survey of the streams of the Ohio River basin (Brinley and Katzin) plankton samples from most of the major watersheds of the Ohio basin were available. Over 1,400 samples were studied, and the data from these, together with existing information, should serve as a nucleus for a more systematic knowledge of the algal and protozoan plankton of these streams.

Procedure

Most of the plankton samples were taken by filling a 250 ml. wide-mouth bottle from the stream; preservation was by the addition of 5-8 ml. of formalin. Some fresh samples were studied soon after collection. Occasional samples were taken with the aid of a plankton net, but these were qualitative only. Quantitative counts were made by the method described by Lackey (1939).

Collections were made during the years 1939 and 1940. Samples from the Ohio River itself were taken in both years; the tributaries were usually sampled in one year or the other. More samples were available for the summer period than for other parts of the year. Wabash and White River samples were taken in August, September and October; Cumberland samples in October and November; Green River basin samples in October; Little Kanawha samples in August; and Monongahela samples mainly in August. In certain watersheds, principally those of the middle third of the Ohio River basin (Miami, Little Miami, Kentucky, Licking, Big and Little Sandy, Guyandot and Kanawha Rivers), samples were collected at some stations at intervals for a large part of the year. At other locations, samples were less frequent, or often isolated.

Only organisms identified at least to genus are listed. Identifications to genus only are partially due to the formalin fixation, and partially to the necessity of covering a large number of samples in a limited length of time. Organisms were listed as "sp." or "spp." when they were either in a state of

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preservation not allowing of further identification, or were recognizable, but could not be closer identified with the literature available. Thus, for example, the *Mallamonas* sp. listed was of the second type, while the *Euglena* spp. fall into the first category. Ciliates preserved poorly in general, and in a number of cases, either disintegrated entirely or left remains that could only be identified as ciliate. For this reason, the numbers and the scattered distributions for some of these forms are not necessarily reliable.

Observations

Under the names of the rivers listed in Table 1 are given the data for these watersheds. Exceptions to this are the Wabash River, in which, due to the large area involved, the principal subwatershed, the White River and its tributaries, is considered separately from the rest of the watershed. Likewise, that portion of the Miami River below the city of Dayton, which profoundly influences the life in the stream, is separated from the upper stream and the tributaries. Another separation is made in the case of the Monongahela River, to emphasize the effect of the acidity of the main stream on the composition of the plankton. Under "Ohio River" are given only the results of samples taken from the Ohio River itself, between Pittsburgh and the mouth.

The distribution of an organism in the watershed is indicated as general (G), restricted (R), or local (L). Its abundance is indicated as generally found in large numbers (N), occasionally found in large numbers (C), generally found in small numbers (O), and occasionally observed (S). "Large numbers" are 100 or more per milliliter. A plus (+) under a given month indicates that the organism in question has been found somewhere in the Ohio River system in the calendar month under consideration. Due to the differences in the watersheds, it has been considered advisable not to attempt designation of months of greater or lesser abundance. Such variations will be indicated to a certain extent in the following discussion.

SEASONAL EFFECTS

A survey of the time distribution for the basin as a whole shows that the seasonal variation, for most of the regularly occurring planktonts, is not marked. Individual watersheds may show more definite seasonal variations, due to the climatic differences in different parts of the Ohio Basin. These seasonal trends are largely quantitative, and can, to a large extent, be traced to specific environmental factors.

A factor which from our records would seem to be very important is temperature. A sharp drop in temperature, or a more gradual fall to a temperature of ten degrees Centigrade or less, will cause a large proportion of the plankton to vanish from the waters of a stream. On the whole, the Bacillarieae, Cryptophyceae, and Chrysophyceae are less affected by temperature than are the other forms, and it is these organisms that form the typical cold-water plankton. Other forms may occasionally be found, even under low temperature conditions, when other factors are exceptionally favorable. It

should be noticed, however, that there are many more organisms which are found only during the warmer times of the year. It is, of course, possible that more intensive collection would occasionally show even these forms at times of low temperature.

Certain variations introduced by seasonal change in environmental factors may be termed "pesudo-seasonal." For example, on the upper Ohio River, there may be found a seasonal progressive change of the plankton. The chemical data show that this may be due to the progressively increasing acidity of the water, due to mine drainage and industrial pollution and the penetration of this acid condition further downstream, as the volume of flow drops off with the approach of summer. Other acid polluted streams may show the same effect. Seasonal fluctuation of food supplies will be discussed below.

In general, the numbers of individuals and of species, and the volume of the plankton (Brinley and Katzin) increase with the onset of warm weather, reaching a peak in August and September. An interesting exception to this is the Ohio River itself, where the reverse change occurs. Some factor linked with the stream size may be involved, possibly nutritional.

NUTRITIONAL FACTORS

Of the factors influencing the distribution of plankton in the Ohio River system, food availability is probably one of the most important. With allowance for the influences of temperature, and acidity—see Lackey (1938) and Lackey (1939)—it is possible to account for the distributions found in terms of the amount and type of food available for the planktonts—cf. Brinley and Katzin. In Table 1, the first seven columns represent the northern streams and the later columns represent the streams entering the Ohio River from the south, excepting the Allegheny. On the whole, the population of the northern waters is decidedly greater, in numbers of individuals and of species, and in volume, than that of the southern streams. This would suggest that the difference in the origin of the water plays a part in determining the population. However, when one considers the Licking and Kentucky Rivers, it is seen that these two watersheds bear a close resemblance to the northern streams. Closer analysis of the data, and consideration of information which cannot be gone into here—see Brinley and Katzin—points to the decisive factor as the amount of organic and inorganic food material available in the water. This in turn has its source, to a large extent, in man-made pollution, especially in the form of urban sewage.

The streams that receive the greatest amount of organic pollution are the Wabash, White, Miami and Little Miami Rivers. It is these streams that show the greatest numbers, variety and volume of plankton. The Ohio itself is the recipient of wastes from a number of large cities, but, probably due to dilution, does not show the effects in the same way. In further confirmation, the greatest numbers, variety and volume of plankton may be found in other streams below sources of pollution.

An analysis of the effects of organic pollution on the chemistry of the stream immediately makes clear the basis for this fertilizing effect. In the

process of bacterial decomposition of the wastes introduced, a series of compounds are formed which may satisfy the nutritional requirements of different organisms in rotation. This furnishes greater variety of ecological niches than occurs in an unpolluted stream. In addition, the introduction of organic materials gives a much greater concentration of a given food base than occurs normally in an unpolluted stream, and allows organisms to appear which do not develop during the more strenuous competition between species occurring when food supplies are more sharply limited. Furthermore, conditions for growth and multiplication of a given species are more favorable, leading to larger numbers of the common forms.

Further differences between the northern and southern streams are based upon the higher content of both organic and inorganic food in the northern soils, supporting heavier plankton populations even in unpolluted reaches, and upon the differences in seasonal cycles of temperature and weather. The northern streams are subjected to winter conditions adverse for plankton growth, which conserve food materials until the rising temperatures in the spring, and the melting of snow and ice accompanying this initiate the spring pulse of plankton which has been often noted. Southern streams, with less severe winters and cold weather of shorter duration, do not have as marked seasonal variation, and spread the generally lower level of food through a longer season of favorable climatic conditions. It should also be pointed out, for the plankton-poor southern watersheds, that a large proportion of the organisms reported was obtained near the mouths of the streams, and only there. These locations are usually subject to backwater from the Ohio River in highwater season, and the presence of organisms found locally may be due to seeding from these flood waters.

PLANKTON DISTRIBUTION

Aside from the effect of food, there seems to be little or no basis, in the data presented, for any general qualitative plankton differences between the northern and southern streams. In other words, the northern plankton does not seem inherently different from that of the southern streams. Differences between two streams on the same side of the Ohio River may be greater than between the groups of northern and southern streams. Such differences as do appear depend upon the distribution of infrequently found organisms and it is as possible that more intensive collecting will eradicate this difference as that it will confirm it. Another possibility, of course, is that differentiation between species of a given genus may reveal differences hidden where genera alone are determined. It is possible that this may, to a certain extent, explain the distributions of some of the common diatoms and of *Chlamydomonas*.

It is interesting to note that the forms which are most widely distributed throughout the Ohio basin are to a large extent those which are found in plankton through most of the year. This includes *Chrysococcus rufescens* and *ovalis*, *Cryptomonas erosa*, *Trachelomonas crebea*, *urceolata*, and *volvocina*, *Euglena pisciformis*, *Chlamydomonas* spp. and several other Chlorophyceae, several of the diatoms, and others. Forms which are more closely dependent

upon a rich food supply, or in other ways have their distribution considerably restricted, are found for shorter periods of the year. In many cases, as has already been suggested, an organism can usually be found at some place in the basin at almost any time of the year.

Some forms which have been found in plankton samples only once or twice might be considered as adventitious visitors, and not primarily stream planktonts. However, this does not necessarily mean that they are not found in streams, either as bottom forms or attached, or even as normal planktonts in the water under the proper conditions. *Closteriopsis*, for example, is rarely found except in the acid Monongahela, and in the acid portions of the Ohio (formed by the confluence of the Monongahela and the Allegheny), where it is rather abundant, often forming almost the whole of the plankton. Another example is *Euglena mutabilis*. It is only reported once in our plankton samples of the Hocking River, while the bottoms of certain regions of the acid tributaries of the Hocking are solid green mats of *Euglena mutabilis*.

The Myxophyceae seem to appear later in the spring than do the majority of the Chlorophyceae. Although occasionally encountered in a May sample, they do not become very common until June. *Oscillatoria* may be an exception to this rule. The distribution and frequency for this group of algae may be rather deceptive. Due to the method of sampling, these organisms might not appear in the plankton, although solid clots of blue-greens, several inches in diameter, could be seen floating on the surface of almost any polluted stream. These clots were mainly *Oscillatoria*, with which were intermixed the other forms. *Lyngbya* may have been present, but could not be readily distinguished from *Oscillatoria*.

The listing of *Stephanodiscus* only in the Wabash and White watersheds (Table 1) is due to the difficulty of distinguishing this genus from *Cyclotella*, in routine examination of samples. In the watersheds named, this organism was so prominent that it received particular attention. In other watersheds occasional individuals may have been lumped with *Cyclotella*.

The Ohio River is a long stream, with several distinctly different regions. The portion between Pittsburgh and Marietta (Ohio) is subject to high acidity in the summer, and this plays a large role in determining the plankton composition and amount, and its change with season. Cincinnati and Louisville are sources of large contributions of putrescible material, and as a result exert a certain influence on the plankton. Nevertheless, several striking differences from the tributary streams can be seen. Euglenophyceae are notably scarce, and Chlorophyceae are not as numerous as might be expected. Occasional forms may appear in larger numbers than in the tributaries (e.g., *Chrysococcus asper, Franceia, Sphaerocystis*, and some diatoms, as *Asterionella*), although this is not the rule. The major component of the Ohio plankton is the group of diatoms. These forms are found in larger numbers than they occur in the tributaries, and are the most consistent members of the catches. Another peculiar feature of the Ohio is the already mentioned dearth of summer plankton, except immediately below Cincinnati and Louisville.

It may be pointed out that there exists a group of organisms, roughly indicated by the taxonomic groups of Chrysophyceae, Cryptophyceae, and Bacillarieae, which are to be found under the most varied conditions of temperature, food concentration, and, often, acidity. Another group, distinct from this resistant or "thrifty" group, formed of *Euglena, Phacus, Lepocinclis,* some Myxophyceae and many Protozoa, is dependent upon a rich food supply, consisting to a large extent of organic matter and bacteria. A third group, consisting mainly of the Chlorophyceae, is intermediate in its needs and resistance between the first two groups. It is the appearance of complexes of the members of the second group, together with large numbers and variety of members of the intermediate and thrifty groups, that serves as clear indication of nearby organic pollution. The thrifty group is represented in practically all waters and is the dominant group in clean and impoverished water.

Summary

This paper is based upon 1,400 samples collected from most of the major watersheds of the Ohio Basin during 1939 and 1940. In general, the species found are widely distributed over the entire basin. The number of individuals and species increases with the onset of warm weather, reaching a peak in August and September. An exception to this is the Ohio River, where the reverse change occurs, largely due to diatoms in the spring.

The streams that receive the largest amount of organic pollution contain the largest number of species and individuals which is probably associated with the amount of available food in the stream.

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CINCINNATI, OHIO.

TABLE 1.—Frequency of distribution of plankton Protozoa and Algae in the major streams of the Ohio River Basin, and their tributaries. Distribution: G = generally distributed; R = restrictedly distributed; L = locally found. Abundance: N = commonly found in large numbers; C = occasionally found in large numbers; O = commonly found in small numbers; S = occasionally observed.

Streams and watersheds	Wabash	White	Miami	Miami tribs.	Little Miami	Hocking	Muskingum	Cumberland	Green	Kentucky	Licking	Little Sandy	Big Sandy	Guyandot	Kanawha	Little Kanawha	Monongahela	Monon tribs.	Allegheny	Ohio River	April	May	June	July	August	September	October	November	December	January
Number of samples	77	32	87	76	133	62	60	21	36	116	67	30	96	38	32	15	6	10	17	438	7	106	106	170	274	280	218	139	6	1
CHRYSOPHYCEAE																														
Chromulina sp.	RO	LS	GO	RO	GO		LS			LS	RS	LS	LS		LS					RS		×	×	×	×	×	×	×	×	×
Chrysococcus																														
amphora					GS					RC	LS		RS													×	×	×		
asper	RO	LS			GO	GO	RS	GO	RC	GS	LS	LS	GO	RO	RS					RC		×		×	×	×	×	×	×	
cylindrica	RS	RS	GS	RO	GS	LS	LS		RO	GO	RC	LO	GC		LS	GO		GO		RS				×	×	×	×	×		×
major	LS	LS	GO	RS	GO	RS	RO		RO	GS	GS	RS	GS	LS	LS					RS	×	×	×	×	×	×	×	×		
ovalis	RO	GO	GO	GC	GN	GO	GC	RC	GC	GC	GC	GC	GO	GC	GO			LS	LS	RO	×	×	×	×	×	×	×	×	×	×
pediformis											LO															×				
rufescens	GN	GN	GN	GN	GN	GC	GN	GC	GC	GN	GC	GN	GC	GN	GO	GC	LS	GO	GC	GC	×	×	×	×	×	×	×	×	×	×
spiralis	RS	RS	LS		GS	RS	RS		RS	RO	LS	GO	GC	LS				RO		RS	×	×			×	×	×	×		×
Dinobryon																														
sertularia	RO	RC	GO	RC	GC	RC	GC	RO	RC	GC	GS	GC	RC		LS	LS		RC	RS	GC		×	×	×	×	×	×	×	×	
Hymenomonas																														
roseola			LS		RS					RS															×	×				
Lagynion																														
scherffelii	RO	RO	GO				GN			GS	LS	LS	LC		LS					RS				×	×	×	×	×		
Mallomonas																														
akrokomas					LS	LS	LS																×				×	×		
caudata	GO	RS	RS	RS	RC	LS	GO	LS		RS	LS							RC	RO	RS				×	×	×	×	×	×	
tonsurata													RO														×			
sp.			GO	GO	GO	RS		RO	RO	GO		LS	RO	LS	RO	LS				RS	×		×	×	×	×	×	×		

Ochromonas																															
mutabilis					LS																										
Synura uvella	LS		RS	LS	GC		RS	LS	LO	RS		LO				LO		LS		RS		×		×	×	×	×	×	×	×
Uroglena volvox					LS																								×		
CRYPTOPHYCEAE																															
Chilomonas																															
paramecium					LS						LC											×	×								
Chroomonas spp.	RO	LS	GO	RO	GO	LS	GS			RO	GO	GS	RO		LS				LO	RS		×	×	×	×	×	×	×			
Cryptomonas erosa	GC	GN	GN	GN	CN	GC	GC	GC	GO	GC	GC	GC	GC	GO	GC		LS	GN	LS	GC	×	×	×	×	×	×	×	×	×		
ovata		RO	GS	GC	GC					RS	GS		LS					LS		RS		×	×	×	×	×	×	×			
Rhodomonas lacustris		RC	GO	LS	RS		LS			LS	RC			LS	LS					RC	×	×	×	×	×	×	×	×			
EUGLENOPHYCEAE																															
Anisonema ovale				LS																								×			
Astasia spp.	LS		LS	RS	LS					LS													×	×	×			×			
Colacium spp.					LS																				×	×					
Cryptoglena pigra	RS	RS	GS	RS	GO	LS				RS	RS													×	×	×	×	×			
Distigma proteus											LS									LS			×			×		×			
Euglena acus	RO	RO	GO	GO	GO	RS	LS		RO	GO	GO	RO	RO			LS		RO		RS		×	×	×	×	×	×				
agilis			RC		LS																					×	×				
deses	RO	RS	GO	RS	RS	LS	RS				RS		RS					RO		LS	×	×		×	×	×	×	×			
Ehrenbergii	RO	LS	RS	RS	RS	RS	RS			LS	LS							RS					×	×	×	×					
fusca											LS									LS						×	×				
gracilis	RO	GO	GC	GC	GO	GO	RS		RO	GO	GC	RO	RO	LS	LO	LS		RC		RS		×	×	×	×	×	×	×			
limosa											LS											×									
mutabilis	RS					LS												LS					×		×						
oxyuris	RS	LO	GO	RS	GS	GS				RS	RS		LS						LS	LS			×	×	×	×	×				
pisciformis	GO	GO	GC	GC	GC	GO	RO	LS	RO	GS	GC	RS	GO	RS	LS	RO		GN	RS	RS		×	×	×	×	×	×	×			
polymorpha	GO	GC	GO	RO	GO	RC	RS		RO	GO	GO	LO	RO	LS		GO		RO	LS	RS	×	×	×	×	×	×	×				
sanguinea										RS																×					
sciotensis																				RS						×	×				
spirogyra	LS		RS												LS					LS				×	×	×	×				
spiroides			LS		LS																			×							
torta	RS		GO	GC	GO	LS	LS		LS	RS	RS				LS					RS				×	×	×	×				
tripteris	RS	LS	LS	LS	LS		RS											LS		RS		×	×	×	×	×	×				
truncata											LS											×									

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Closteriopsis longissima	LS	LS	LO		LS											GN		LO	RC				×	×	×	×		
Closterium spp.	RS	GS	GS	RO	RS	RS	GO		LS	RO	RS	LS	RO	LS	RS		LS	RS	RS		×	×	×	×	×	×	×		
Coccomonas orbicularis	RO	RS	RS	RS	RC	RO	RS	RS		GO	GS		GC			GC	RO	LS	RS				×	×	×	×	×		
Coelastrum spp.	GC	GC	GO	GO	RO	RS	RC	RS			RS	LS	RS				LS	RS	RS		×		×	×	×	×	×		
Coelosphaerium sp.					LS																				×				
Cosmarium spp.	RO	RS	GO	GO	GS	RS	RS			RS	RS	RO	GS	RS	GS	LS		RO	GO	RS		×	×	×	×	×	×	×	
Crucigenia spp.	GO	GO	GO	RO	GO	RO	RO		RS	GS	RS	LS	LS	LS	LO					RS			×	×	×	×	×	×	
Dictyosphaerium spp.	GC	GN	GN	GC	GO	GC	RO	RO	LS	GO	GS	RS	GO	LS	LS				RS	GO	×	×	×	×	×	×	×	×	×
Dimorphococcus sp.																				LS		×							
Dysmorphococcus Fritschii							RS									RO				RS		×		×	×		×		
Euastrum spp.			LS									LS		LS						RC							×	×	
Eudorina elegans	RS	RS	GC	LS	RS		RS	LS		GO	GC	RS		LS	LO				RS	RO		×	×	×	×	×	×	×	
Franceia spp.			GS	RS	LS								RS							RC			×		×	×	×	×	
Gloemonas sp.	LS																								×				
Golenkinia spp.			GS	RS	LS					RS			RO	LS						RS			×	×	×	×	×	×	×
Gonium pectorale	LS	RS	GO	RS	RS		RO			RS	RS		LS		LS					RO		×	×	×	×	×			
sociale	GO	GS	GO	LS	LS	LS	RO			RS	LS	LS	LS						LS	RS	×	×		×	×	×	×		
Heteromastix angulata	RO	GO	GO	RO	GC	RO				GS	RC		LS	LS			RO			RS		×	×	×	×	×	×	×	
Kirchneriella spp.	RS	GO	GO	RS			RS		LS	LS			LS			LS		RS		RS			×	×	×	×	×	×	
Lagerheimia spp.	RS	RO	GO	RO	RS					RS			RS	LS	LS					RS			×	×	×	×	×	×	×
Lobomonas rostrata	LS	LS	GS	LS	RS						RS											×	×	×	×	×			
Mesostigma grande	RO		GS						RS																×	×			
viride	RO	LS	GO	GO	GO					GS	LS		RS							RS			×	×	×	×	×		
Micractinium spp.	RS	RC	GO	RO	LS	RS	RS	LS		RS	RS		RS		RS					GS		×	×	×	×	×	×	×	
Microspora spp.				LS	LS					LS	LS											×	×						
Mougeotia spp.											LS									RC			×	×	×	×	×	×	
Oocystis spp.	GO	RN	GO	RO	GS	RS	RC	RO		GO	RS		LS	LS			LS	RS	GO				×	×	×	×	×	×	
Pandorina morum	GO	GS	GO	GO	GC		RO	GO	LS	GC	GC		RS		RS	GC	RO		RO			×	×	×	×	×	×	×	
Pediastrum spp.	GO	GN	GO	RO	GS	GO	RO	LS		RO	RS	RS	LS	LS	RO		LS		RS	RO		×	×	×	×	×	×	×	×
Pedinomonas spp.			LS	LS							RS		LS							RS							×	×	
Pedinopera spp.	RS	LS	LS		LS	LS		LS		RS	LS					LS		LS		RS				×	×	×	×	×	
Phacotus lenticularis	GC	GC	GN	GN	GC	RO	RS			RC	GC	LS	LS	LS	LO			LS		RO		×	×	×	×	×	×		

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Chroococcus spp.	GO	RC	GO	RO					LS	LS			LS			LS			RS	RS				×	×	×	×	×			
Merismopedia spp.	GC	GO	GO	GO	RO	RO	RS	LS		GS		LS	RS	LS	RS	RS		LS	RS	RO			×	×	×	×	×	×			
Microcystis spp.	GN	GC	GO	RC	RS	LS	RS	RS	LS	GS			RS	LS	LS		LS	LS	RS	RO			×	×	×	×	×	×			
Oscillatoria spp.	GS	RS	GO	RO	GO	GC	RO			GO	LS				LS	RS		LS	RS	RS		×	×	×	×	×	×	×			
HETEROKONTAE																																
Botryococcus braunii	RS	RO	GO	RS	LS						LS									RS				×	×	×		×				
BACILLARIEAE																																
Amphiprora sp.							RS															×									
Amphora spp.			LS	LS	LS		RS															×	×								
Asterionella formosa	RS		LS		LS	LS	GN			RS	LS		LS						RO	RC	×	×	×	×	×	×	×	×			
Attheya spp.	RS		LS				RS			RS			LS							LS				×		×	×				
Cyclotella spp.	GC	GC	GN	GN	GC	GC	GN	GO	LS	GC	RC	RO	GO	GS	RS	LS		RC	RS	GN	×	×	×	×	×	×	×	×	×			
Cymbella spp.	RS		RO	RO	GS	LS	LS						LS		LS			LS		RS			×	×	×	×	×		×			
Diatoma spp.			RC	LS	RO	RS	RC			LS	LS		RO							RC			×	×	×			×	×	×	×	
Eunotia spp.	LS					RS	LS		LS																×			×				
Fragillaria spp.							RS			RS	LS								LS	RO			×	×	×	×		×	×			
Gomphonema spp.		LS	GO	GO	GO	RC	RS		LS	RS	RS		RS	LS						RC	×	×	×	×	×	×	×	×			
Gyrosigma sp.																				LS					×							
Melosira spp.	GC	GC	GN	RC	RS	RC	GC	GO	GO	RC	RS	RO	RS	LS	LN	LS		RC	GC	GC			×	×	×	×	×	×	×	×		
Meridion spp.			LS			LS																	×	×								
Metridium sp.						RS																	×	×								
Navicula spp.	GN	GC	GN	GN	GN	GC	GC	GO	GC	GO	GO	GO	GC	GO	GC	GO	LS	GN	GC	GC	×	×	×	×	×	×	×	×	×			
Nitzschia spp.	GC	RC	GC	GC	GC	GC	GC	RO	RO	RC	GC	RO	GO	GC	GS	GO	RO	GC	GO	RC	×	×	×	×	×	×	×	×	×			
Orthozira sp.													RS													×		×				
Pinnularia sp.											LS												×									
Pleurosigma spp.	GS	RS	GS	GO	GS	GS	RS		RS	RS	LS	LS		LS		RO				RS			×	×	×	×	×	×				
Rhizosolenia spp.			LC							LS													×			×						
Stephanodiscus sp.	RC	RC																								×	×					
Surirella spp.	RS	RS	GO	RO	GS	RS	LS			RS	RS	LS	RS	RS				LS	RO	RS	×	×	×	×	×	×	×	×	×			
Synedra acus	RS	RC	GC	GC	RC	LS	GC			RC	GS	RS	RS	LS	LS			LS	RO	GN			×	×	×	×	×	×	×	×		
biceps	LS	RO	GO	GO	GC	RS	RC		LS	RS	GS	RO	RC	GO	RS				RS	RC			×	×	×	×	×	×	×	×		
radians	RO	RS	GN	RC	LS		LS	LS		RS									RO	RO			×	×	×	×	×	×	×			
ulna	GS	RO	GO	RS	LS	RS	RC		RS	LS	LS	LS	RS	LS	RS				RS	RS	×	×	×	×	×	×	×	×				

PROTOZOA

Acineta sp.																			LS									×			
Actinobolus sp.			LS																		×	×									
Actinophrys sol	LS		GS	LS	LS	LS	RO			RS	GS		LS						RS		×	×	×	×	×		×			
Actinosphaerium spp.	RS					LS	LC												RS			×	×	×		×				
Amoeba spp.	RO	RS	GO	RS	GO	LS	RO	LS		GS	GS	LS	RO	LS	RS				RO	×	×	×	×	×	×	×	×	×	×	×
Anthophysa sp.								LS																			×				
Arcella spp.			LS	LS	RS	LS				RS	LS	LS	LS		LS				LS			×	×	×	×		×			
Aspidisca costata			LS		RS	LS				LS									LS		×	×	×	×	×					
Bodo spp.	LS		GS	RS	GS					RS	GS	RS	RS						RS	×	×	×	×	×	×	×				
Caenomorpha medusula											LS											×								
Ceratium spp.	LS		RS	LS								LS			LS	LS			RS			×		×	×	×	×			
Chilodonella spp.				LS	RS														RS			×		×			×			
Cinetochilum margaritaceum					LS																×									
Cladomonas fructiculosa			GS	LS	RC	RO				GS	RS		GS						LS				×	×	×	×	×			
Codomonas annulata	GO	RS	GS	RS	RS	RO	RO	LS		RS		LS			LS				RS			×	×	×	×	×	×			
Codonella cratera	LS		GS	RS	GO		RS	LS	RS	GO	LS	RS			LS		LS	LS	RO			×	×	×	×	×	×	×	×	×
Coleps hirtus	LS		LS		CS						LS											×	×	×	×	×				
Collodictyon triciliatum	RO	RO	GO	RO	CO	LS	RO	LS		GS	GS	LS	RS	LS					RO			×	×	×	×	×	×	×		
Colpidium colpoda			LS		RS					LS	RS	LS	GS	LS					RS			×	×		×		×	×		
Colpoda spp.			LS	LS	LS																			×		×		×		
Colponema loxodes				LC																				×						
Condylostoma caudatum					LS																					×				
Cyclidium spp.	GO		GO	RS	GO	RO	RO	GO	GO	GS	GS	RS	GO	RS	RO	LS			RS	×	×	×	×	×	×	×	×	×	×	×
Didinium spp.	RO	RS		LS	RS	RS	LS						LS						LS			×		×	×	×	×			
Diffugia spp.			RS		LS	LS				RS	LS							LS	RS				×		×	×		×		
Domatomonas spp.	GO	RO	GO	RS	GC		RS		RO	GO	GO	GO	RS	LS	LS	GO		LS	LS	RO			×	×	×	×	×	×		
Frontonia spp.			LS								LS											×	×							
Glaucoma scintillans		RO	RS		RS	LS					LS		GS	LS			LS		RS			×	×		×	×	×	×		
Hastatella sp.																LS									×					

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The Plankton Algae and Protozoa of Two Tennessee Rivers

James B. Lackey

Introduction

Literature dealing with the plankton of rivers in the United States is scant. San Joaquin River plankton has been studied by Allen (1920) and Illinois River plankton by Kofoid (1903), Forbes and Richardson (1913) and Purdy (1930) who also studied the Ohio (Purdy 1923). Eddy (1932) has made some observations on the Sangamon and the writer (Lackey 1938, 1939) on the Scioto. In all of these the list of plankton species has been a somewhat brief one, and does not compare in number of species with the more lengthy lists from some of the lakes. Certain differences from lake plankton have been noted, but it is a question as to whether distinct plankton groups may be set up for lake and river environments.

We have found no mention in the literature of Tennessee River plankton. Shoup (1939) noted two papers dealing with Reelfoot Lake (Tennessee) plankton. Eddy (1930) in 1928-29 found 72 species of algae and protozoa in this lake, naming 16 of the greatest importance. The writer (unpublished data) found 104 species in 1935, and Bevel (1938) found 210 species in 1938. Comparing the three lists, we find 265 different species of Algae and Protozoa thus far found in Reelfoot Lake. Many of these are bottom forms, or at least not characteristic of the plankton of streams. But most of them have also been recorded from streams at one time or another, especially investigations dealing with stream bottoms.

In 1938 a number of water samples were collected by Mr. F. W. Kittrell, Sanitary Engineer of the Tennessee State Health Department, from various streams in Tennessee and sent to the writer. These were all from the watersheds of the Cumberland and Duck Rivers. In 1939 the writer made a plankton survey of these two rivers. In all, 66 samples were analyzed, of which 18 were fresh samples and 48 preserved. These were either centrifuged and the fresh catch examined or preservd with formalin and the catch allowed to settle after which the supernatant was decanted. Besides these samples, a few were available from the Tennessee River, as well as the results of 68 analyses of Cumberland River water at Old Hickory, Tennessee, made between October 11, 1938, and October 9, 1939, which were very kindly furnished through the courtesy of Mr. W. J. Eldridge, Water Purification Supervisor for the DuPont Rayon Company at Old Hickory. The Cumberland and Duck Rivers were shown to have a lengthy list of plankton protozoa and algae. Both streams have been sampled at various times of the year, although very few winter samples were examined; 12 of the 68 samples from the Old Hickory

water plant intake were taken in December, January and February 1938-39. In all samples, 203 species of Algae and Protozoa, representing 149 genera, were identified. Table 1 gives a list of all these organisms and shows how frequently they were noted in each of the two watersheds, as well as the maximum number in any one sample.

TABLE 1.—Plankton Organisms of the Cumberland and Duck Rivers.

	Cumberland River		Duck River	
	No. Samples in which occurred	Maximum number per ml.	No. Samples in which occurred	Maximum number per ml.
ALGAE				
Myxophyceae				
Anabaena spiroides	1	1		
Anabaena sp.	4	12		
Aphanocapsa sp.	10	20		
Chroococcus sp.	2	10		
Coelesphaerium sp.	1	4		
Lyngbya sp.	3	4		
Merismopedia tenuissima	17	25	12	28
Microcystis aeruginosa	4	20		
Oscillatoria sp.	3	17	8	7
Rivularia sp.	1	4		
Sirosiphon sp.	1	4		
Spirulina sp.			1	1
Bacillarieae				
Amphora sp.	5	16		
Asterionella formosa	2	4		
Asterionella gracillima	2	6		
Attheya zachariasi	1	4		
Cocconeis sp.	2	2	6	4
Cyclotella meneghiniana	67	472	17	608
Cymbella sp.	32	36		
Encyonema sp.	5	8		
Diatoma hiemale				
Fragilaria crotonensis	1	2	1	3
Comphonema olivaceum	31	22	4	14
Gyrosigma sp.	6	4	3	2
Melosira granulata	23	235	7	33
Melosira varians	6	11		
Navicula spp.	63	40	24	56
Navicula minuta	4	35	1	800
Nitzschia acicularis	10	68	1	30
Nitzschia minuta	5	2880		
Pleurosigma sp.	17	12	5	5
Pinnularia sp.	1	1		
Rhizosolenia eriensis	4	30	1	10
Rhoicosphenia sp.			1	1
Stephanodiscus sp.	2	4		
Surirella sp.	8	20	4	2
Synedra ulna	2	4	2	2
Synedra ulna var. *biceps*	1	3	4	4

TABLE 1.—(Continued)

	Cumberland River		Duck River	
	No. Samples in which occurred	Maximum number per ml.	No. Samples in which occurred	Maximum number per ml.
Synedra ulna var. *delicatissima*	1	1	1	1
Synedra ulna var. *radians*	6	24	3	28
Synedra sp.	49	32		
Dinophyceae				
*Gymnodinium gracilis**	1	1		
Gymnodinium sp.	12	36	5	22
Peridinum quadridens			3	2
Unidentified dinoflagellata	23	200	14	46
Heterokontae				
Botryococcus sp.	1	4		
Centritractus belonophorus			1	1
Ophiocytium capitatum			1	1
Cryptophyceae				
Chroomonas sp.	11	170	3	60
Cryptomonas erosa	36	340	9	350
Cryptomonas ovata	12	96	1	3
Cryptochrysis sp.	3	13		
Nephroselmis sp.	1	3		
Rhodomonas lacustris	5	30	2	20
Chrysophyceae				
Chrysococcus aspera	11	400	2	10
Chrysococcus cylindrica	1	5	2	4
Chrysococcus hemispherica	1	10		
Chrysococcus major	5	8	2	10
Chrysococcus ovalis	6	55	2	10
Chrysococcus rufescens	31	136	12	150
Dinobryon sp.	2	34	1	162
Lagynion Scherffeli	1	48		
Mallomonas, small species	19	30	4	15
Mallomonas, large species	1	4		
Synura uvella, colonies	12	14		
Chloromonadida				
Gonyostonum depressum	3	5		
Euglenophyceae				
Cryptoglena pigra	2	16	1	5
Euglena acus	3	2	3	10
Euglena deses			1	1
Euglena Ehrenberghii			1	10
Euglena fusca			1	2
Euglena limosa			1	2
Euglena oxyuris	1	2	2	8
Euglenia pisciformis	7	4	5	8000
Euglena polymorpha	9	4	2	100
Euglena sanguinea	1	1		
Euglena Sciotensis	1	1	1	1
Euglena spirogyra			1	1

TABLE 1.—(Continued)

	Cumberland River		Duck River	
	No. Samples in which occurred	Maximum number per ml.	No. Samples in which occurred	Maximum number per ml.
Euglena velata	5	54	1	160
Euglena viridis			4	24
Euglena spp.	30	28	17	146
Lepocinclis ovum	4	5		
Lepocinclis texta	1	1		
Phacus anacoleus			1	10
Phacus brevicauda			1	2
Phacus longicauda			1	1
Phacus pleuronectes			1	1
Phacus pyrum			2	2
Phacus triqueter			1	1
Trachelomonas crebea	33	70	15	310
*Trachelomonas cylindrica**			1	350
Trachelomonas eurystoma	2	2		
Trachelomonas hispida			1	5
*Trachelomonas punctata**			2	2
Trachelomonas urceolata			14	190
Trachelomonas volvocina			5	290
Peranema trichophorum			1	1
Chlorophyceae				
Carteria spp.	3	13	1	100
Chlamydomonas spp.	47	456	18	480
Chlorogonium elongatum	1	20	3	10
Collodictyon triciliatum	3	50	6	25
Dysmorphococcus Fritschii	6	4	8	55
Eudorina elegans	23	36		
Gonium pectorale	6	5	3	2
Gonium sociale	2	4		
Heteromastix angulata				
Lobomonas rostrata	5	12	1	2
Scherffelia phacus			1	295
Sphaerellopsis fluviatile			1	2
Pandorina morum	62	652	11	72
Pedinomonas minor	1	5		
Pedinopera granulosa	1	10		
Phacotus lenticularis			6	240
Phacotus sp. (large)			1	56
Platydorina caudata	6	9	1	10
Platymonas elliptica			1	1
Pteromonas aculeata	5	7	4	10
P. aculeata var. *Lemmermanni*				
Pteromonas angulata (?)	20	71	8	600
Pteromonas cruciata	7	88		
Pteromonas sp.	3	16	1	1
Pyramidomonas sp.			1	20
Thoracomonas phacotoides	20	35	7	40
Thoracomonas sp.	5	150	4	190
Wislouchiella planctonica	9	16	6	4
Volvox sp.	1	24		
Acanthosphaera Zachariasi	2	80	1	5

TABLE 1.—(Continued)

	Cumberland River		Duck River	
	No. Samples in which occurred	Maximum number per ml.	No. Samples in which occurred	Maximum number per ml.
Actinastrum gracillimum	17	12	4	5
Actinastrum Hanschii	6	36	3	24
Ankistrodesmus falcatus	10	14	7	20
Ankistrodesmus var. *mirabilis*	20	20	9	88
Closteriopsis longissima	11	5	6	24
Closterium sp.	15	8	2	5
Coelastrum cambricum	16	7	6	10
Coelastrum microporum			2	2
Cosmarium sp.	40	36	4	4
Crucigenia apiculata	1	16	2	4
Crucigenia Lauterbornei			1	40
Crucigenia tetras	11	44		
Conferva sp.	1	8		
Desmatractum bipyramidatum	2	4		
Desmidium sp.	2	8		
Dictyosphaerium pulchellum	27	70	6	16
Franceia tuberculata	13	20	3	38
Gleocystis sp.	1	4		
Golenkinia paucispina			2	2
Golenkinia radiata	2	170		
Kirchneriella obesa	1	10	1	12
Lagerheimia Chodati	2	4	3	16
Lagerheimia longiseta			1	10
*Lagerheimia minutus**	2	10		
Micractinium pusillum	13	60	2	20
Oocystis crassa	16	20	1	24
Pediastrum Boryanum	4	4		
Pediastrum duplex	1	5		
Pediastrum simplex	8	20	2	1
Pediastrum sp.	2	8		
Penium sp.	5	4		
Planktosphaera gelatinosa	1	2		
Polyedriopsis spinulosa	1	5		
Polyedrium sp.	10	44		
Protococcus sp.	9	52		
Scenedesmus sp.	43	28	11	68
Schroederia setigera	5	4	4	10
Selenastrum gracile			3	14
Sorastrum sp.	3	8		
Staurastrum sp.	3	4		
Staurogenia sp.	2	4		
Spirogyra sp.	1	4		
Tetraedon minutus	1	1		
Tetraedron sp.	2	35	1	8
Tetrallantos Lagerheimii	1	1		
Tetraspora sp.	6	24		
Tetrastrum anomalum	2	7	1	2
Tetrastrum heteracanthum			1	2
*Tetrastrum minutus**			1	12
Tetrastrum staurogeniforme	4	4	1	8
Treubaria crassispina	3	10	4	10
*Trochischia papillosus**	8	42	1	12

TABLE 1.—(Continued)

	Cumberland River		Duck River	
	No. Samples in which occurred	Maximum number per ml.	No. Samples in which occurred	Maximum number per ml.
Trochischia reticularis	6	50	4	32
Ulothrix zonata	16	32		
Westella botryoides	4	16	5	14
PROTOZOA:				
Mastigophora				
Anthophysa vegetans	2	7	3	5
Bicoeca lacustris	2	10	3	35
Ciadomonas fruticulosa	10	120	2	30
Codomonas annulata	1	15		
Domatomonas cylindrica	3	5	2	10
*Domatomonas camapanulata**	1	5		
Oicomonas termo	6	120	1	10
Poteriodendron etiolatum			1	10
Sarcodina				
Actinophrys sol.			1	5
Amoeba radiosa	1	1	1	10
Amoeba sp.	1	1	1	5
Difflugia globosa	4	1		
Difflugia lebes			3	2
Difflugia sp.	2	8		
Gocevia sp.	3	5	1	1
Nuclearia simplex	1	5		
Pamphagus mutabilis	1	1		
Raphidiophrys pallida	4	25	4	10
Infusoria				
Bursaria sp.	1	1	1	1
Chilodonella uncinatus	2	1		
Cinetochilum margaritaceum	1	1	1	3
Codonella cratera	15	25		
Coleps hirtus	3	20	1	1
Cyclidium glaucoma	7	3	10	20
Cyrtolophosis mucicola	1	1	1	2
Dactylochlamys sp.			1	2
Didinium nasutum			1	1
Frontonia leucas			1	1
Glaucoma pyriformis	1	1	1	7
Halteria grandinella	6	4	2	4
Nassula ornatus			1	2
Oxytrichia sp.	2	4		
Paramecium caudatum	1	1	1	1
Prorodon sp.	1	1		
Stentor polymorphus			1	2
Stentor sp.	1	4		
Strobilidium humile	13	10	9	2
Strombidium gyrans	5	2	2	1
Tintinnidium fluviatile	9	6	1	2
Trachelocerca sp.			1	2
Urotricha farcta	5	1	17	12
Vorticella sp.	16	4	3	4

(*) Denotes provisional name or classification.

The Plankton Groups

Blue-green algae were not abundant in number; eleven genera were recognized. Only Merismopedia and Oscillatoria were found in Duck River plankton, and since the latter occurred but five times, very few species could have been represented. The single species of Merismopedia, *tenuissima*, probably represents the sole truly limnetic member of the Myxophyceae in these samples. Examination of bottom material would certainly have shown a much larger species list, because patches of blue-greens were abundant on submerged objects.

Twenty genera of diatoms were found and a large number of naviculoid species could have been identified. The most frequently occurring form was the planktonic Cyclotella which was found in all but 4 of the Duck River samples, and in half of the Cumberland River samples. Navicula and closely related genera were next, in 57 Cumberland and 16 Duck River samples. Many of these were undoubtedly adventitious forms from the bottom. The same probably holds true for Cymbella, found in 32 Cumberland samples. Surirella, Pleurosigma, Gyrosigma and Amphora were each found in several samples. *Melosira granulata* was common and abundant in both rivers, while *Melosira varians*, usually frequent in colder months, occurred in 7 Cumberland samples. Other plankton diatoms were Stephanodiscus, *Asterionella formosa, Synedra ulna* var. *biceps, S. ulna* var. *radians, S. ulna* var. *delicatissima, S. ulna* and an unidentified species of Synedra. *Rhizosolenia eriensis* was abundant in the September samples, and was found at 6 stations. *Attheya zachariasi* was found at one station in the Cumberland. This diatom has not been previously reported in North American rivers, although the writer has found it in the Scioto and Ohio Rivers. It differs slightly from the figured European forms, notably in the sculpturing, but the differences are probably not of specific value. In general, the diatom flora is a representative one, comprising many bottom forms as well as the usual plankton species.

Dinoflagellates were fairly common in the samples, although their numbers were never very large. Identification was not attempted for most of them. The most frequent species was *Peridinium quadridens*. Ceratium was not found. Heterokontae were very few. *Ophiocytium capitatum* was found in a single Duck River sample. The curious *Centratractus belonophorus* not heretofore noted in this country was found in several Duck River samples, while *Botryococcus* sp. was reported at Old Hickory by Mr. Eldridge.

Euglenophyceae were much more common to the Duck River than to the Cumberland. In the Cumberland, unidentified species of Euglena were found in 30 samples, and eleven species of various euglenid genera were identified, compared to unidentified species of Euglena in 15 Duck River samples. Twenty-six species of Euglenophyceae were identified in this river. In all the Cumberland samples Phacus was not found. *Trachelomonas crebea* and *T. urceolata* were widespread. They seem to be typical potamophile forms. Under the latter species we have probably included several closely related forms. We have shown elsewhere (Lackey and Smith 1940) a close intergradation of several species near this one. None of the species of Euglenophyceae are

unusual, unless it be *Euglena Sciotensis*, previously described from the Scioto River.

Cryptophyceae were represented by four genera: *Cryptomonas erosa* was most common, in 32 and 9 samples from the Cumberland and Duck Rivers respectively. Chrysophyceae were represented by six genera and eleven species. The commonest was *Chrysococcus rufescens* in 31 and 11 samples. Species determinations were not made for Mallomonas.

The Chlorophyceae were most abundant of all plankton forms. About 50 species of the non-motile forms, mostly Chlorococcales, were found and 24 of Volvocales. Desmids were poorly represented. *Desmatractum bipyramidatum* (Fig. 1), a rare alga, was found in each river. Our specimens had greatly attenuated ends whereas those found by Taft (1939) in Michigan had short apices. A number of the Volvocales were either new to North America or only sparingly reported. *Dysmorphococcus Fritschii* was noted in 16 samples; *Lobomonas rostrata* in 6; *Platymonas elliptica* in 2; *Pedinopera granulosa* in 1; *Platydorina caudata* in 7; *Polytoma granulifera* in 1; *Pteromonas angulata* in 27; *P. aculeata* var. *Lemmermanni* in 13; *P. cruciata* in 8; and *Wislouchiella planctonica* in 14. This last species has been a common plankton form of the Ohio River system and integradations between the type form and *Pteromonas cruciata* are common. These genera probably need a critical taxonomic examination. *P. aucleata* var. *Lemmermanni* was very abundant in Rock Creek below Lewisburg in 1938; on August 24 there were 186 per ml. But in September, 1939, only 20 per ml. were found at the Lewisburg station, while the original station had less than 1 per ml.

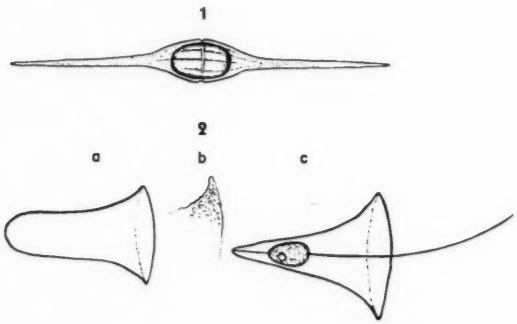

Fig. 1. Tennessee and Ohio Valley form of Desmatractum. The elongate ends are wholly unlike the figured American species, or the figure of West.

Fig. 2. a. Campanulate lorica of a Tennessee specimen of Domatomonas. b. Detail showing nature of lorica. c. Still another shell type for this organism.

A curious green flagellate, previously reported in the U. S. only by Bevel (1938) was *Gonyostomum depressum* (Chloromonadida) found at three stations in the Cumberland. The writer has never found any other representative of the Chloromonadida in rivers, although *Gonyostomum semen* occurs at times in abundance in woodland pools, and has been found by him in a cedar swamp at Woods Hole, Mass., and a cypress swamp at Waterloo, Alabama.

The colorless flagellates were rare in the plankton. *Bicoeca lacustris* was epizoic on Cyclotella anl Micractinium. *Cladomonas fruticulosa* occurred in ten samples, mostly those of relatively high turbidity. *Codomonas annulata* was found, and Domatomonas was rather usual in 9 samples. But Cumberland River forms of this genus had a widely flaring lorica (Fig. 2) instead of the usual cylindrical one. A few of the latter were found, but there was no intergradation between the two.

Rhizopods were scarce. Perhaps the only unusual one was *Gocevia* sp. which we have found only in rivers, and noted from three stations on this survey. Ciliates were also rare, but the plankton forms *Codonella cratera*, *Halteria grandinella*, *Strobilidium humile*, *Strombidium* sp., *Urotricha farcta* and *Tintinnidium fluviatile* were fairly numerous and outranked all others in importance. Sixteen species of the ciliates might be counted as bottom dwelling forms. They occurred 41 times, whereas the 7 planktonic ciliates occurred 95 times.

Discussion

Stream plankton, unlike that of a lake, is not apt to indicate any too clearly the condition of the water at the point of occurrence. Of course, if entering substances modify the condition of the water too greatly, an immediate deleterious effect would be apparent; but the entrance of substance favorable to plankton production would produce a multiplication whose distance from the point of entrance would be determined by the speed of the current, and the number of still areas as dead arms or bays, below the point of entrance of favorable substances. It is difficult to judge the nature of a stream from its plankton content unless the bio-chemico-physical nature of the stream be well known. Even then the factors influencing plankton production may be missed. Practically nothing is known of the phosphorus-plankton relationship in streams for example.

Nevertheless, certain organisms appear to thrive in a stream whose organic load is or has recently been high, while others are thereby inhibited to various degrees. In our study (1942, in press) of the Scioto River of Ohio, the Cryptophyceae and Chrysophyceae have shown a marked reduction on entering a zone of pollution and an increase downstream when the water has become at least partially purified again.

In the Cumberland 200 Cryptophyceae per ml. and 186 *Chrysococcus rufescens* per ml. have been found at Nashville, where pollution is pronounced. Within a few miles below the center of the city a pronounced drop to 4 and 20 per ml. respectively, was noted, and the highest numbers, 340 and 400

per ml. respectively, were counted about 60 miles below Nashville, where the river is again a fairly pure stream. The Cumberland is a much larger stream than the Scioto yet these two groups of flagellated plankton, on the basis of relatively few samples, seem to behave in a similar fashion in the two rivers. The same two groups in the Duck River give little information, being abundant over a long stretch of the river, and affording an excellent example of the difficulty of judging the river condition on the basis of a few samples.

This last statement is also supported by the behavior of some other species. *Euglena pisciformis*, which we consider favorable to, but not necessarily indicative of pollution, was identified in only 11 scattered samples. In 10 of these its maximum number was 4 per ml., but in Rock Creek, below Lewisburg, there were 8,000 per ml. in 1939, whereas none were found there in 1938. Rock Creek is a small stream, and at that time had a very small flow of clear water, getting some pollution from the Lewisburg treated sewage and creamery wastes. These, however, were not noticeable several miles below town where the sample was taken, and whatever the cause of this "bloom," the large numbers were probably accumulated in part because of a very slow flow in the creek. *Euglena polymorpha*, *Trachelomonas crebea*, *T. urceolata*, *T. volvocina* and *T. lacustris* Drez. (or *T. cylindrica* var. *punctata* Playfair) were also abundant in this same sample.

Trachelomonas crebea occurred in 49 samples in these two rivers. Except for Rock Creek it was scarce in the Duck River watershed while above Nashville its numbers were small in the Cumberland. But in 1938, its numbers increased rapidly from 4 per ml. at Old Hickory to 40 per ml. 16 miles further down at Nashville, and in 1939 from 15 per ml. at Old Hickory to 70 per ml. several miles below Nashville. *T. urceolata* showed a slight increase in the same area. These two species were the most abundant of the genus in the Scioto River but failed there to show a clear cut reaction to pollution.

Evidently some waste was favorable to the large increase of *T. crebea* in the river near Nashville. Above Old Hickory the sewage and industrial wastes entering the river are not great, but in 1930 the sewered population at Old Hickory was 10,000. A large viscose rayon plant is also located there. Some organic load is therefore added to the river, while at Nashville considerable industrial waste and the sewage from about 150,000 people enters the river. There is an oxygen sag, but no depletion, at least not when these samples were taken. The samples containing large populations were taken at low water, those in 1939 at extreme low flows.

The Cumberland is a canalized river and extreme slowness of the current in this stretch was a very noticeable feature in 1939. Evidently canalization allowed sufficient time for exposure of a plankton population to contributed substances which might favor multiplication and for aggregation or even stratification of a motile population.

The truth of this observation is indicated by the mode of occurrence of *Pandorina morum* in this river sector. From the bridge at Old Hickory, vivid

green streaks were visible, several feet wide, and hundreds of feet long, two or three of them extending up and down river. The same thing was true at Swintons Camp several miles below Nashville. A sample of one showed a dense population of Pandorina. This flagellate is common in the river from June until the end of November, according to the data of Mr. Eldridge, with a late summer bloom. Apparently the combination of the factors of contributed organic matter and slow flow tend to bring about such blooms in rivers, and are favorable to the development of huge plankton populations. Pandorina occurred in 52 of our samples from the Cumberland and Duck Rivers and while abundant in the lower Duck in 1938 it nowhere approached the numbers found in the Cumberland near Nashville, nor the large numbers found in the cleaner parts of the Cumberland well above and below Nashville. Such behavior of Pandorina is additional evidence that it is an indicator of pollution when it occurs in large numbers.

Butcher (1932) is of the opinion that much of the plankton of English streams with which he worked, is derived from the sessile algae of the river bed. In such a large stream as the Cumberland, and especially the canalized portions, there is a decided scarcity of bottom growing algae. This is one of the bad features of canalization—there is a deposit of silt, stones become covered, and a decided diminution of algae aside from plankton types occurs. The Cumberland has apparently a smaller plankton, both qualitatively and quantitatively, than the Scioto, but its smaller plankton is not necessarily due to canalization, for the Muskingum River, about like the Scioto, is canalized yet has a plankton comparable to that of the Scioto. Canalization with its attendant slowing up of time of flow, should aid plankton increase, if nutrient materials are sufficient to support a large population. That a portion of this nutrient matter is due to sewage is evident from the situation around Nashville, where the Cumberland is richest in plankton. In its physical features the Duck seemed to us to resemble the Scioto except that it gets the sewage of a very much smaller population. If sewage is a powerful fertilizing agent, we would expect the Duck to be poorer in plankton than the Scioto, since the latter gets more sewage. Such is precisely the case, the Scioto contains a greater number of species and a much more abundant population.

Studies of river plankton should cover considerable time and space, if the river is to be classified. There seems to be little doubt that sewage, treated or raw, fertilizes a river for a distance dependent on the amount of sewage and speed of current. Sufficient fertilizing material would make the classification involve a consideration of the amount of plankton due to sewage, rather than geologic and geographic features. In the Duck we have probably dealt with a "natural" plankton, in the Cumberland one profoundly modified by man-made contributions to the river.

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The Genus Tremellodendron

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Tremellodendron is a small genus of the Tremellaceae, with a basidiocarp externally somewhat similar to that of a *Clavaria* or a *Lachnocladium* but structurally and microscopically resembling the Sebacinas included in the section *Eusebacina* as defined by McGuire (Lloydia 4:5. 1941). The genus has been described only from North America, but the existence of two tropical species in the West Indies, coupled with the fact that the tremellaceous nature of the fructification remained for so long unrecognized, makes it quite possible that further examination of South American collections will yield some representatives. Lloyd (Myc. Writ. 7:1174. 1923) describes as *Tremellodendron dubia* a specimen from Brazil, but the description and the accompanying illustration make the name seem extremely appropriate.

The external characteristics of the genus were described by Schweinitz (Naturf. Ges. Leipzig Schrift. 1:110. 1822) but it was not until 1902 that Atkinson (Jour. Myc. 8:106. 1902), after examining specimens of *Thelephora candida* (Schw.) Fries and *T. pallida* Schw. discovered the tremellaceous character of the fructifications, and erected for them a separate genus. Burt (Ann. Missouri Bot. Gard. 2:731. 1915) published the standard treatment, supplementing his paper by the publication of additional notes in 1922 (op. cit. 9:67) and in 1926 (op. cit. 13:339). Coker's treatment (Jour. Elisha Mitchell Soc. 35:113. 1920) adds little to that of Burt. Lloyd's notes (Myc. Writ. 6:1049; 7:1154, 1357) are valuable.

The experienced collector has no difficulty in distinguishing the genus in the field. The fructifications are erect, pileate, subfleshy to coriaceous, and occasionally club-shaped, but usually branching freely. The microscopic structure of all species examined is uniform. The central part of the fructification is composed of parallel strands of unbranched hyphae extending the length of the basidiocarp. This region is not at all gelatinous, and the strands may be separated by tapping upon the cover glass under which a longitudinal section has been mounted. Surrounding the central region is the subhymenium, the hyphae of which branch and anastomose freely. From this layer rises the hymenium, typically subgelatinous and composed of branching paraphyses and the characteristic cruciate-septate basidia of the Tremellaceae. No clamp connections are discernible, nor have I found cystidia nor gloeocystidia.

The fructifications are extremely variable in size, in color, and in habit of growth. Such variations seem to be influenced, in part at least, by the environmental conditions under which the basidiocarps develop. An examination of specimens collected over a period of about ten years reveals that those matured in hot, dry summers are conspicuously different from those produced during cool, moist seasons. The present summer (1941) began

with a season of rain and cool weather, followed by about ten days of dryness and extreme heat. During the dry period, growth of the young basidiocarps was abruptly halted. Immature specimens of *Tremellodendron pallidum* (Figs. 1, 2) and of *T. candidum* collected after another rainy period were found to have begun to grow around the edges of the cushion-like original growth, producing a fructification which curiously resembles a daisy. The same tendency has been noted in collections of other years. An herbarium specimen of *T. Cladonia* shows proliferation at the tip of the stipe, beneath and outside of branches already developed.

The age of a specimen may have some effect upon the color. It must be remembered that a fertile hymenium is produced before the basidiocarp is fully developed. In addition, *Tremellodendron*, like other tremellaceous fungi, may suspend growth under unfavorable conditions, and resume it when the conditions become suitable. Some specimens have been found, apparently fully grown, with the tips darkened and drying, but with the hymenium scarcely apparent, and shedding no spores. All these factors make difficult any attempt to correlate the development of the fungus, its age, and its color. The hymenium usually appears only after the fructification has reached considerable size, and the branches are well developed. It appears first on the stipe, and then grows upward upon the branches, finally becoming amphigenous. The tips of the branches appear to be always sterile. The hymenium is at first a light or warm buff, the sterile portion being pallid or sordid white. In the earlier stages the hymenium may be perfectly fertile, producing a large crop of spores, as shown by spore prints. As the fructification grows older, it darkens, and the hymenium eventually assumes its full color, which may be russet in late stages of *Tremellodendron merismatoides*, or fuscous in *T. tenax*.

The problem of deciding where the species distinctions occur is extremely difficult. Differences between species have in the past been decided mainly by the external characters, and the wide variability of such characters has led to much confusion. This study was undertaken with the hope of finding some constant character or group of characters which may be used as the basis for distinguishing between fluctuating differences resulting from environmental peculiarities, and those real and constant characters which indicate a true species.

The following study is based upon the specimens in the herbarium of the State University of Iowa which were collected over a period of about thirty years by Prof. T. H. Macbride, Prof. B. Shimek, and Prof. G. W. Martin and his students. By far the greater number of specimens were collected in Iowa, in the vicinity of Iowa City, but there are collections from other parts of the state, and also from New Jersey, New York, Vermont, Ohio, Tennessee, Wisconsin and New Mexico. The rarer species are included for the sake of completeness.

Fresh specimens in various stages of development were brought into the laboratory and examined. Fresh, as well as dried and soaked specimens

were examined under a binocular microscope, and free hand sections, longitudinal and transverse, were studied at a magnification of about x900. Portions of the hymenium were also examined, and spores studied from spore prints, and compared with spores found upon the hymenium. All materials for microscopic study were moistened with alcohol, drained, and a small amount of 3% potassium hydroxide added to the mount. A drop of 2% aqueous phloxine was then added. After a few minutes this was drained away, and more KOH added. The result is a brilliant mount in which the basidia, spores and paraphyses are clearly visible.

The following characters were studied as possible points of distinction:

1. *Size.* — The length and breadth of each specimen was measured. I did not consider thickness, as the dried specimens had been more or less flattened during the drying process.

2. *Habit of growth.*—The nature of the stipe, type and extent of branching, appearance of tips, consistency of the fructification, and location and appearance of the hymenium were observed.

3. *Color.*—The colors of fresh, dried, and dried and soaked specimens were compared with Ridgway's *Color Standards*. Immature specimens were compared with mature ones wherever possible.

4. *Trama.*—Hyphae making up the core and subhymenium were carefully measured, and compared as to color, cell size, and nature of branching.

5. *Hymenium.*—Sterile elements were measured and compared, and the basidia measured at full maturity, just before the appearance of the epibasidia. I considered this to be the point at which the longitudinal septa appear.

6. *Spores.*—Fully mature, discharged spores were collected from spore prints and their length and breadth measured. Methods of germination also were noted.

The results are a little disappointing. At first there appear to be no clear-cut distinctions, but only a series of characters which almost imperceptibly grade into one another. Closer study reveals the presence of certain tendencies, or "peaks," as it were, which vary with different species and which, viewed cautiously and with regard for the whole picture, may be held to be indicative of species differences. Bresadola (Hedwigia 35:292. 1896) recommends that when microscopic characters are identical or very similar, external characters be given very careful consideration; but when both are lacking in clearly defined traits, the systematist must be on the alert to observe every character, and every combination of characters which may indicate species differences.

Of the six characters which I studied, two seem entirely negligible. The first of these is size. We have specimens of *T. candidum* which are as large as our largest *T. pallidum; T. merismatoides* as large as representative *T. candidum* and other specimens of *T. merismatoides* so small that they suggest

a different species (Fig. 18). The hymenium also is remarkably uniform. The basidia of one species cannot be distinguished from those of another, all that I have examined being usually pyriform and falling within the size limits 12-15 x 8-11μ. The paraphyses are alike (Fig. 26).

The manner of growth separates the genus into two distinct groups. *T. merismatoides* is the prototype of one group. The stems are slender and may be slightly grown together. The branches are terete, dividing again and again into very fine branchlets, which dry to a hair-like size. Fresh young specimens are pallid, and the hairlike branches appear very early. Young specimens when dried are a little darker than members of other species, and the well-grown specimens are very dark, the color approaching russet. To accompany these external characters, the medullary hyphae are somewhat more slender (usually less than 3μ) than those of other species. The fructifications are waxy or horny when dried, suggesting a tremellaceous fungus.

The second group includes *T. pallidum, T. candidum, T. tenax* and *T. Cladonia*. These are fleshy when fresh, dull and powdery rather than waxy or horny when dried, and with the branches much larger than in *T. merismatoides*. The parallel hyphae of the trama are often over 3.5μ in diameter. Fresh specimens are pallid, *T. pallidum* and *T. candidum* becoming light buff when older, and usually drying warm buff. The hymenium when it appears is warm buff, and may later become ochraceous, and finally even reddish. *T. Cladonia* lacks the warm color of the two preceding, and usually dries a rather light buff, with a duller hymenium which sometimes becomes cinnamon drab. *T. tenax* is distinguished by a hymenium which becomes purplish or fuscous, although we have here collections which are unmistakably *T. tenax* but which have a hymenium warm buff or ochraceous. These were gathered early in the season. Soaking and drying also has some effect upon the color of the hymenium. A specimen of *T. tenax* which was distinctly fuscous before it was soaked dried with its hymenium a deep red.

T. pallidum and *T. candidum*, which are very similar in coloring, may be distinguished by their method of branching. The stems of both species are frequently fused, but the branches of *T. candidum* are free, and rounded (Figs. 3, 5, 6). Those of *T. pallidum* are sometimes entirely fused, and flattened, giving a rosette-like appearance to the fructification (Figs. 4, 7, 8). Occasionally, spore sizes will assist in assigning the species. The spores of *T. candidum* are somewhat lacrimate and small—practically identical in size and shape with those of *T. merismatoides*. The spores of *T. pallidum* are more allantoid in shape, and may be a little longer. The difference is very slight.

The growth habits and method of branching of *T. Cladonia* make it almost unique among our species. The specimens are often found singly (Figs. 9, 10, 11), usually scattered but gregarious, whereas the others are often more closely grouped. The branching is sparse, the stems frequently dividing palmately into three branches (Fig. 10).

The single character which seems to me to be most nearly constant is the spore size, but the value of this is vitiated by several factors. It is of almost

no value in distinguishing between *T. candidum* and *T. pallidum* (Figs. 22, 23). Occasionally a basidium will produce only two spores. These will be much larger than ordinary, but can usually be detected immediately. The spores germinate by repetition, the secondary spores being much smaller than the original ones (Fig. 24a). Once these have broken away from the sterigmata it is difficult to identify them. There is no printed description which indicates adequately the wide range of spore size, even though we disregard the possibility of "giant" and of secondary spores. There are, however, comparisons which may be valuable. The spores of *T. tenax* are larger than the spores of any other temperate species, and every actively fruiting hymenium will contain some of them. This will set apart a specimen of *T. tenax* which approximates *T. candidum* in color. A spore print made from an actively fruiting *T. Cladonia* always contains some rather slender, cigar-shaped spores which are unmistakable (Fig. 24). The spores of *T. candidum*, *T. pallidum* and *T. merismatoides* are almost identical (Figs. 22, 23, 25). So far as the microscopic characters are concerned, there is very good reason for doubting that these are separate species. The color and method of branching of *T. merismatoides* sets it apart immediately. Although *T. pallidum* and *T. candidum* seem to intergrade, the differences in methods of branching are so great in typical specimens (Figs. 5, 8), and appear so early (Figs. 6, 7) that I feel that unless more conclusive evidence to the contrary is presented, they should be regarded as separate species.

This study was begun at the suggestion of Prof. G. W. Martin, and completed in the mycological laboratories of the State University of Iowa.

TREMELLODENDRON Atkinson, Jour. Myc. 8:106. 1902

Basidiocarps erect, coriaceous or tough; scattered, gregarious or caespitose; branching or rarely club-shaped; stems and branches distinct or anastomosing; hymenium inferior or amphigenous, waxy when moist, horny when dry, restricted to stem and lower part of branches; tips sterile; basidia cruciate-septate; spores subglobose to allantoid, hyaline, germinating directly by means of a germ tube or by repetition.

Found on the ground in woods during wet weather in summer and early autumn.

Type species: *Merisma candida* Schw.

KEY TO THE SPECIES

a. Fructifications more or less branched, rarely nearly simple ..... b

a. Fructifications unbranched, or with crestlike expansion at apex ..... f
b. Fructifications caespitose, much branched, often anastomosing c
b. Fructifications separate, usually sparsely branched, gregarious or scattered ..... e

c. Fructification up to 10 cm. tall, pallid to warm buff; branches broadly flattened, anastomosing to tips, forming rosette-like structures when well developed; spores 8-10 x 4-6μ, occasionally 10-12μ in length ..... 1. *T. pallidum*

c. Fructifications usually smaller; anastomoses confined to stems; branches rounded, or sometimes flattened at tips ..... d

d. Fructification up to 10 cm. tall; pallid to warm buff; hymenium ochraceous to tawny; branches free, at least 1.5 mm. thick; terete, sometimes flattened at the tip; spores usually 8-10 x 4-6μ ..... 2. *T. candidum*

d. Fructifications up to 6 cm. tall; pallid; hymenium cinnamon drab to fuscous, occasionally reddish; branches free, at least 1.5 mm. thick, terete and tapering or flattened at tip; spores 10-15 x 5-7μ ..... 3. *T. tenax*

d. Fructifications up to 6 cm. tall; pallid, hymenium dark, horny, whole fungus sometimes becoming russet; branches free, terete, 0.5 mm. or less thick, drying hairlike; spores 8-10 x 4-6μ ..... 4. *T. merismatoides*

e. Fructifications rarely more than 5 cm. tall; pallid; hymenium dull, approaching cinnamon drab; stems rounded, free, branching palmately into a small number of flattened branches; spores 10-12 x 5-6μ ..... 5. *T. Cladonia*

e. Fructifications up to 3.5 cm. tall; stems free, flexuous, very sparsely branching; spores 14-16 x 6-7μ. Jamaica ..... 6. *T. tenue*

f. Fructification dark orange. North Carolina ..... 7. *T. aurantium*

f. Fructification black except for olive-ocher basal hymenium. Cuba and Puerto Rico ..... 8. *T. simplex*

1. TREMELLODENDRON PALLIDUM (Schw.) Burt, Ann. Missouri Bot. Gard. **2**:734. 1915.

Plate 1, Figs. 4, 7, 8

Thelephora pallida Schw., Trans. Am. Phil. Soc. n.s. **4**:166. 1832.
Thelephora Schweinitzii Peck, Ann. Rept. N. Y. State Mus. **29**:67. 1878.
Tremellodendron Schweinitzii (Peck) Atk., Jour. Myc. **8**:106. 1902.

Fructifications on the ground, caespitose, erect, up to 10 cm. in height, 15 cm. in diameter; stems confluent or fused into a basal mass; fleshy-coriaceous, solid; pallid to warm buff, drying light to warm buff, hymenium ochraceous buff to ochraceous tawny, or tawny, usually inferior; entire basidiocarp cinnamon to Sayal brown when soaked; branches extremely flattened, anastomosing, forming rosette-like clusters in well-developed specimens; basidia pyriform, 12-15 x 8.5-11μ; spores subglobose to allantoid 7.5-10(–12) x 4-6μ, germinating by the production of a germ tube or by repetition.

Type locality: Bethlehem, Pennsylvania.

Distribution: Maine to western Ontario south to South Carolina and Missouri; New Mexico.

Illustrations: Hard, Mushrooms f. 381; Lloyd, Myc. Writ. 7, f. 3205; Ann. Missouri Bot. Gard. 2, pl. 26, f. 6; Jour. Elisha Mitchell Soc. 25, pl. 44.

Specimens examined: New Mexico, Cloudcroft, Shimek 1905; New York, Geneva, F. C. Stewart NYAES 312; New York, Hemlock Grove, Burnham and George, NYBG; Iowa, twenty-eight collections.

This common, large species is unmistakable when well-developed. There are, however, some forms which closely resemble *T. candidum*. This has led Coker (Jour. Elisha Mitchell Soc. 25:153. 1920) and Martin and Huber (Univ. Iowa Stud. Nat. Hist. 12(4):98. 1927) to consider it a variant of *T. candidum*. The basal mass, fused stems and flattened, confluent branches forming a rosette appear very early in development and seem to be constant. It seems desirable, therefore, to retain *T. pallidum* as a separate species.

The specimen from New Mexico was collected by Prof. Shimek in 1905. It is young, and has no hymenium. It is, so far as I know, the only collection that has been recorded from the southwest.

2. TREMELLODENDRON CANDIDUM (Schw.) Atk. Jour. Myc. **8**:106. 1902.
Plate 1, Figs. 3, 5, 6

Merisma candida Schw. Naturf. Ges. Leipzig Schrift. **1**:110. 1822.
Thelephora candida (Schw.) Fries, Elenchus Fung. 168. 1828.

Fructifications terrestrial, caespitose, erect, up to 12 cm. in height, more frequently about 6 cm., up to 15 cm. broad, fleshy-coriaceous, pallid, drying warm buff; hymenium inferior then amphigenous, warm to ochraceous buff, drying ochraceous to tawny, rarely ferruginous to Kaiser brown; cinnamon to Sayal brown when soaked; branches terete or subterete, dividing, somewhat flattened at the tip, or bluntly rounded, sometimes fibrous, twisted when dry; anastomoses more frequent in stem; probasidia 12-14 x 8-11μ; spores broadly ovate to allantoid, 8-10 x 4.5-5.5μ, germinating by repetition.

Type locality: North Carolina.

Distribution: Vermont to Iowa, North Carolina, Mississippi and Missouri.

Illustration: Ann. Missouri Bot. Gard. 2, pl. 26, f. 3.

Specimens examined: Mississippi, Natchez, B. Shimek; Wisconsin, Friess Lake, J. F. Brenkle, 12; Tennessee, Great Smoky Nat. Park, L. R. Hesler 10676; Ohio, Seven Caves, W. B. Cooke 5424; Iowa, thirty-three collections.

This seems to be our most frequently occurring species. It is set off from *T. pallidum* by its free, sometimes fibrous and twisted branches. There are times when the basal portion is fused into a mass, and there is some suggestion of confluence in the basal portion of the branches, but the ends of the branches are always entirely free. A season of rain followed by drought, or even a continuously rainy season may be the cause of the fusion in the basal parts of the fructification. Its brighter color and smaller spores set it off from *T. tenax*, and the thicker branches and lighter color from *T. merismatoides*.

3. TREMELLODENDRON TENAX (Schw.) Burt, Ann. Missouri Bot. Gard. **9**:67. 1922.
Plate 2, Figs. 15, 16, 17

Clavaria tenax Schw. Trans. Am. Phil. Soc. n.s. **4**:182. 1832.
Merisma tenax (Schw.) Lév.. Ann. Sci. Nat. Bot. III. **5**:157. 1846.
Pterula tenax (Schw.) Sacc. Syll. Fung. **6**:742. 1888.
Tremellodendron Hibbardii Lloyd, Myc. Writ. **6**:1049. 1921.

Fructifications on the ground, coriaceous; caespitose, erect, up to 6 cm. in height, 1-5 cm. broad; stipitate, the stipes slender, distinct or confluent; pallid, drying pallid to light or warm buff, hymenium at first warm buff or cinnamon buff, becoming cinnamon brown or russet, also cinnamon drab or fuscous; more often inferior than amphigenous, color varying when soaked; stipe subcylindrical, branches subterete or flattened, subdividing into branchlets rounded and tapering to the tip or often flattened and fleshy at the tip; basidia pyriform or subglobose, 12-15 x 8-11μ; spores allantoid, 10-15 x 5-7μ, germination by repetition.

Type locality: Bethlehem, Pennsylvania.

Distribution: Massachusetts, Pennsylvania, Iowa.

Illustrations: Ann. Missouri Bot. Gard. 9, pl. 11, f. 105, 106; Lloyd, Myc. Writ. 6, f. 1947.

Specimens examined: Massachusetts, Ann Hibbard, Lloyd Myc. Coll. 32698 (*Tremellodendron Hibbardii* of Lloyd); Iowa, nineteen collections.

The dark hymenium and large, allantoid spores characterize this species. The tips seem to show two distinct forms, one a rather fleshy, flattened type (Fig. 17), and the other rounded, and tapering to a point (Fig. 16). The species is probably not so rare as Lloyd would lead one to believe.

4. TREMELLODENDRON MERISMATOIDES (Schw.) Burt, Ann. Missouri Bot. Gard. 2:740. 1915.

Plate 2, Figs. 18, 19, 20

Clavaria merismatoides Schw. Trans. Am. Phil. Soc. n.s. **4**:182. 1832.

Merisma Schweinitzii Lév. Ann. Sci. Nat. Bot. III. **5**:157. 1846.

Thelephora pteruloides Berk. & Curt. Lond. Jour. Bot. **1**:238. 1849.

Lachnocladium merismatoides (Schw.) Morgan, Jour. Cinc. Soc. Nat. Hist. **10**:193. 1888.

Pterula merismatoides (Schw.) Sacc. Syll. Fung. **6**:742. 1888.

Fructification terrestrial, caespitose, erect, 2-6 cm. in height, 1-4 cm. broad, stipes more or less fused, coriaceous, drying horny; pallid, drying warm buff or darker; hymenium ochraceous tawny, or tawny to russet or mahogany red; when soaked, ochraceous tawny or tawny; branches extremely fine, drying to a hair-like thinness, relatively free from anastomoses; basidia 12-15 x 8-10μ; spores suballantoid or broadly ovate, 8-10 x 5-6μ.

Type locality: Bethlehem, Pennsylvania.

Distribution: Massachusetts to South Carolina and west to Iowa and Missouri.

Illustration: Ann. Missouri Bot. Gard. 2, pl. 26, f. 4.

Specimens examined: Wisconsin, Richfield, J. F. Brenckle 42; Iowa, thirty-two collections.

The dark color and fine, hair-like branches, with the horny aspect of the dried specimen, separate this species, which is finer and more delicate than any of the others. Coker's illustration (Jour. Elisha Mitchell Soc. 35, pl. 45) suggests *T. candidum* rather than *T. merismatoides* as here interpreted.

5. TREMELLODENDRON CLADONIA (Schw.) Burt, Ann. Missouri Bot. Gard. 2:738. 1915.

Merisma Cladonia Schw. Naturf. Ges. Leipzig Schrift. **1**:110. 1822.

Thelephora Cladonia (Schw.) Fries, Elenchus Fung. 168. 1828.

Thelephora gracilis Peck, Bull. Torrey Club **25**:371. 1898.

Fructifications rising from a subiculum 1-2 mm. in thickness, or directly from the ground, solitary or gregarious, erect, 1-5 cm. in height; 0.5-3 cm. broad; stipitate, the stipe 1-3 mm. in diameter; soft coriaceous; pallid, drying light to warm buff; hymenium varying from light ochraceous brown to cinnamon and Sayal brown, in older specimens cinnamon drab, inferior or amphigenous; soaked specimens cinnamon to Sayal brown, hymenium not evident when wet; stipe cylindrical, branching palmately at the tip into a small number of flattened branches which may rebranch, or dividing into a number of cylindrical or subcylindrical branches, which eventually become flattened; tips regularly flattened, thin, membranous; basidia pyriform, 13-15 x 8.5-10μ; basidiospores broadly ovate to allantoid, often fusiform 8-10(–12) x 4-6μ, germinating by repetition.

Type locality: North Carolina.

Distribution: New England and southern Canada to Iowa, south to Georgia and Mississippi.

Illustration: Ann. Missouri Bot. Gard. 2, pl. 26, f. 1, 2.

Specimens examined: Vermont, Dorset, G. W. Martin, 1771; Ohio, Ash Cave State Park, W. B. Cooke, 5613; Virginia, near Washington, W. A. Murrill; Iowa, fifteen collections.

The distinct, cylindrical stipe, absence of anastomoses, rather abrupt, palmate branching, with the branches often in threes, along with the flattened tips and dingy color make this species quite distinct. The presence of some, at least of the larger spores may be due to such factors as failure of the basidium to divide into four cells, but I feel that the occurrence of some rather long, fusiform spores is regular enough, when combined with the preceding characters, to be indicative of *T. Cladonia*. I have noticed the conspicuous subiculum (Fig. 14) only in collections of this species.

6. TREMELLODENDRON TENUE Burt, Ann. Missouri Bot. Gard. 2:740. 1915.

Fructifications scattered, erect, very slender, 2-3.5 cm. tall, of which 1.5-2.5 cm. represents the stem, 3 mm. broad, coriaceous-soft, drying warm buff; stem equal, flexuous, 0.5-1 mm. thick, sometimes giving off two or three scattered, divergent, small branches, dilated above and divided into a few palmately arranged branchlets; hymenium inferior, on the dilated portion and branches; probasidia 20-24 x 12-14μ, becoming cruciate-septate; spores colorless, curved, pointed at both ends, 14-16 x 6-7μ.

Type locality: Chester Vale, Jamaica.

Distribution: Jamaica, in wet, mountainous regions.

Illustration: Ann. Missouri Bot. Gard. 2, pl. 26, f. 7.

The description, adapted from that of Burt, and the illustration cited, suggest close relationship to *T. Cladonia*, from which it may be distinguished by the longer stem, the sparse branching and the somewhat larger spores.

7. TREMELLODENDRON AURANTIUM Atk. Ann. Myc. 6:59. 1908.

Fructification unbranched, tough, slender, 1-3 cm. tall, 2-3 mm. thick, dark orange; probasidia subglobose, 10-12μ in diameter, becoming cruciate-septate; spores oboval-subelliptical, granular, then with an oil drop, hyaline, 7-10 x 5-6μ.

Type locality: Blowing Rock, North Carolina.

Distribution: Known only from the type locality.

The type specimen has been lost, but the description is sufficient to identify the species should it again be collected.

8. TREMELLODENDRON SIMPLEX Burt, Ann. Missouri Bot. Gard. 2:742. 1915.

Fructification erect, tough, blackish, unbranched but expanding above into an infundibuliform pileus; total height 2-3 cm., diameter of pileus up to 1 cm.; pileus olive-buff, glabrous; hymenium inferior, testaceous, the margin olive-ocher; stem black, rugose, compressed, 2 cm. in length, 1.5 mm. in diameter; probasidia ovate, 11 x 7μ, becoming cruciate-septate; spores hyaline, 7.5-9 x 5-6μ.

Type locality: Puerto Rico.

Distribution: Puerto Rico, Cuba.

Illustration: Ann. Missouri Bot. Gard. 2, pl. 26, f. 5.

The above description attempts to combine the original description of

Burt and the supplementary notes published in Ann. Missouri Bot. Gard. 13:339. 1926.

SPECIES EXCLUDENDA

TREMELLODENDRON CUNEATUM Lloyd, Myc. Writ. 4; Notes 546. 1916.

(*Stereum cuneatum* Lloyd, Myc. Writ. 4: letter 54:7. 1915).

Examination of a fragment of the type collection shows this to be a homobasidiomycete, and probably a *Stereum*.

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MUNDELEIN COLLEGE,
CHICAGO, ILLINOIS.

PLATE 1—All figures reproduced at approximately natural size.
Figs. 1, 2. *Tremellodendron pallidum*. Unusual growth form. Fig. 3. *Tremellodendron candidum*. Immature specimen. Fig. 4. *Tremellodendron pallidum*. Young form showing basal mass. Fig. 5. *Tremellodendron candidum*. Typical mature specimen. Fig. 6. *Tremellodendron candidum*. Top view of young specimen showing free branches. Fig. 7. *Tremellodendron pallidum*. Top view of young specimen showing rosette-like arrangement. Fig. 8. *Tremellodendron pallidum*. Typical mature specimen.

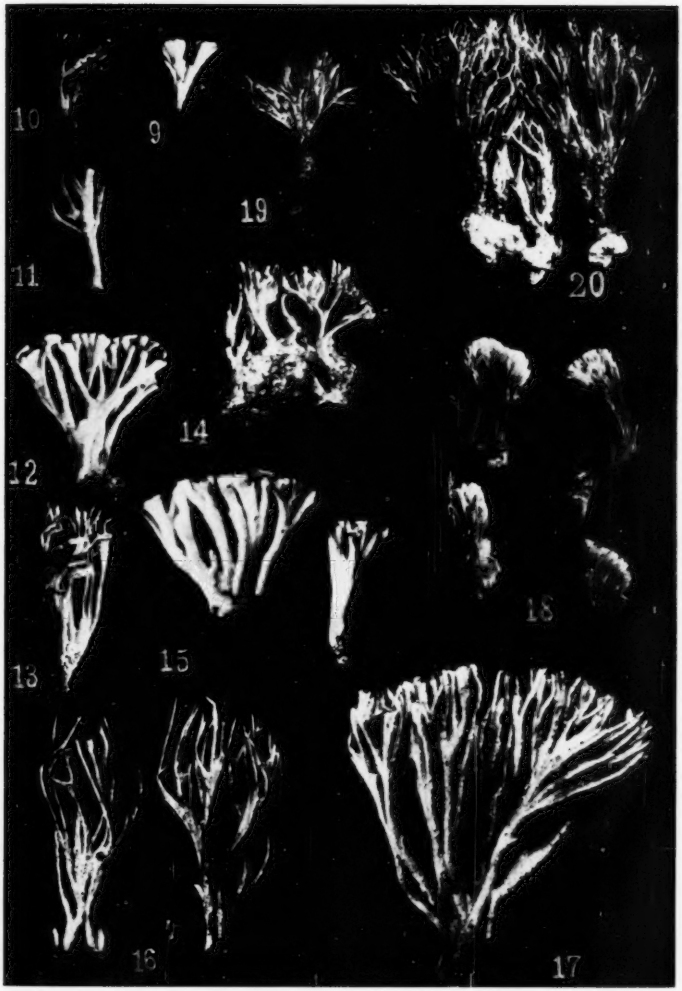


PLATE 2—All figures reproduced at approximately natural size.

Figs. 9-14. *Tremellodendron Cladonia*. 9. Young specimen. 10. Typical mature specimen. 11. Solitary specimen, larger form. 12. Larger form showing expanded, membranous tips. 13. Specimen approaching *T. candidum* in form. 14. Form showing conspicuous subiculum.

Figs. 15-17. *Tremellodendron tenax*. 15. Young specimens. 16. Mature form showing slender tapering branches. 17. Mature form showing branches with rounded, fleshy tips.

Figs. 18-20. *Tremellodendron merismatoides*. 18. Small form. 19. Young specimen. 20. Typical mature specimen.

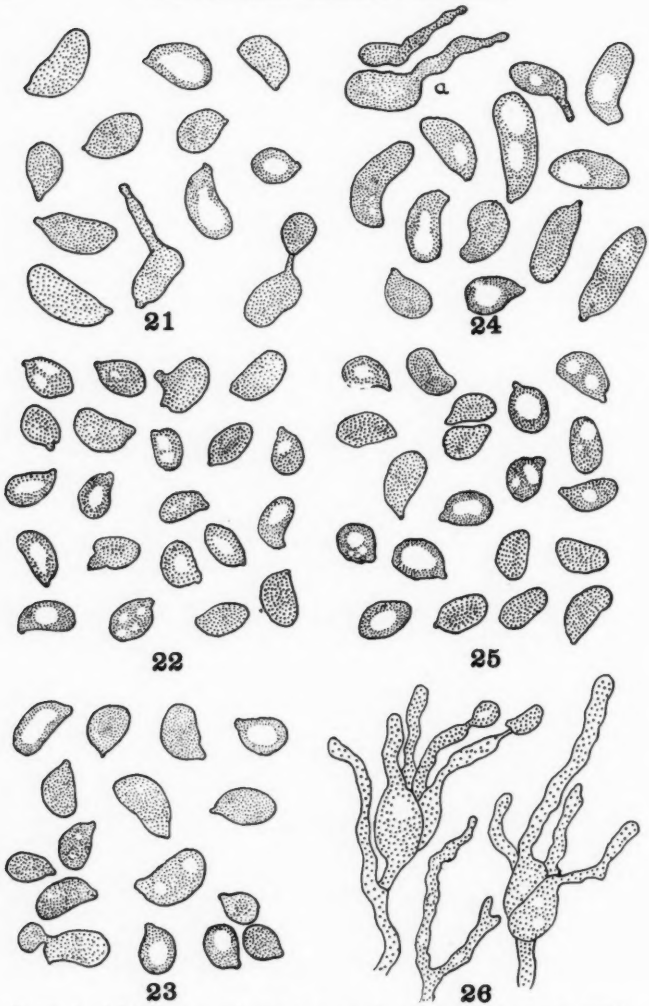


PLATE 3—All figures reproduced at a magnification of approximately ×1000.

Figs. 21-25. Typical spores from spore prints. 21. *Tremellodendron tenax*. 22. *Tremellodendron candidum*. 23. *Tremellodendron pallidum*. 24. *Tremellodendron Cladonia*. a. Germinating spores. The smaller may be a secondary spore. 25. *Tremellodendron merismatoides*. 26. *Tremellodendron candidum*. Two mature basidia and tip of paraphysis showing branching.

The Willows of Colorado

Ernest C. Smith

Introduction

Critical studies of American Willows by Camillo Schneider and Carleton R. Ball have made the treatment of this group in the manuals available for the Rocky Mountain district quite unsatisfactory. Both these writers emphasize the need for intensive study of the group in limited areas where the same individual plant can be visited at different seasons and where many living specimens can be compared.

Such an intensive study has been carried on by the present writer during the past five years. While many parts of the state have been visited in order to get first-hand knowledge of distribution, the really intensive work has been confined to the northeastern part of the state. It is possible to drive from Fort Collins on the edge of the plains to alpine heights in less than four hours. This gives opportunity for frequent visits throughout the season to areas in which all but three rare species of the willows occurring in the state are found in abundance.

Visits to the herbaria of the University of Colorado, the University of Wyoming, Harvard University and the Arnold Arboretum, supplemented these field trips. Specimens for study were loaned by the New York Botanical Garden and the Field Museum. Dr. C. R. Ball not only checked identifications, but also furnished notes of distribution in Colorado as illustrated by specimens in the U. S. National Herbarium and in his own very large collection.

The purpose of this paper is to record the results of these studies and to provide a manual of the willows of the state which is not only critical and up to date, but is also usable by interested persons who are not experienced in plant identification. It is sought to achieve this second purpose through the inclusion of information excluded from ordinary manuals by limitations of space, by separate keys for the staminate and pistillate forms, by a glossary of descriptive terms and by diagrams to make clear the structure of inflorescences.

Physical Features of Colorado

Colorado lies between the 37th and 41st parallels and the 102nd and 109th meridians. The extreme length east and west is about 387 miles and its width approximately 276 miles. It is roughly divided into three sections.

The east third consists of rolling plains which, except along the streams,

are treeless. They slope gradually from an elevation of 3500 ft. at the eastern boundary to 5,000 or 6,000 ft. where they meet the foothills.

The central portion is mountainous, consisting of two main ranges running north and south, sometimes well separated, sometimes coming together, forming divides between the enclosed spaces. These ranges are very rugged, with several peaks reaching an altitude of 14,000 ft. and have been cut and carved by ice and water. Extensive areas are above timberline, here varying from 10,500 ft. to 11,500 ft. Between these two ranges are four large areas known as "parks." Portions of these are well watered and afford optimum conditions for willow growth. They range in size from North Park, 30 miles north and south, 20 miles east and west, to San Luis Park, 100 miles long, 50 miles wide. Some portions of these parks appear nearly level, with wide meadows through which streams find their winding way; other portions have a broken surface and considerable variations in altitude. In general the altitude is between 7,000 and 10,000 ft. In all cases they are hemmed in by mountains from 3,000 to 6,000 ft. above the valley floors. In addition to these large parks there are other smaller open areas referred to by the same name. These are quite commonly the melting plains of extinct glaciers.

The western third of the state is distinguished by the presence of numerous large and small high tablelands or mesas which are cut by deep gorges. In the southern part these formations give place to the rugged mountain masses of the San Juan and Elk ranges.

For the most part the mountains, except on steep, southward facing slopes, are densely covered with coniferous forests, — western yellow pine, Douglas fir, blue spruce, lodgepole pine, Engelmann spruce, subalpine fir, limber pine or bristle-cone pine, occurring in this order from the plains to timberline. In the southern part of the state scrub oak and pinon pine supplant the yellow pine at the lower altitudes.

Distribution of Willows

It is clear that these physical features affect the occurrence of willows. Most species require an abundant and fairly continuous supply of water during the growing season. Even those which grow in so-called "dry" situations must have adequate moisture during a part of the season. Another factor of great significance in the mountain areas is the dense cover of coniferous forests. Willows avoid deep shade and do not grow in the forested areas even when the moisture supply is adequate.

The annual precipitation in rain and snow varies from 6.5 inches in some parts of the San Luis Valley to 50 inches at Cumbres, only 50 miles away. In general, Colorado is considered "semi-arid." The plains district and the larger valleys are dependent for any fairly continuous supply of water on the rain and snow falling in the mountains and on the plateaus. Thus the physical features limit the occurrence of willows in general to the banks of streams and ponds in the eastern section and to the open spaces in the mountain districts.

When we consider the distribution of species, rather than that of the genus as a whole, another factor becomes important, altitude. Its influence is twofold, first, on the occurrence of species and second, on the size of the plants. On the latter point it is noticeable that *S. planifolia* var. *Nelsoni*, which above timberline rarely grows more than 6 dm. high, at 7500 ft. averages 3 m. in height. While the effect of altitude upon the distribution of species is real and important, many species of willows occur within such wide ranges of altitude as to make any hard and fast distribution into the usually accepted zones impossible. This fact is brought out impressively in the altitudes assigned to specimens cited in connection with the descriptions of species. Nevertheless it is worth while to list the names of those most commonly found at various elevations. Used in connection with the keys, such lists may be helpful in making identifications.

ALPINE

By "alpine" we mean "occurring above timberline" which, in Colorado, varies between 10,500 and 11,500 ft. Eight species or varieties occur in this region. Four are strictly alpine, *S. nivalis* and its var. *saximontana*, *S. petrophila* and *S. cascadensis*. All are prostrate plants, the flowering branches rarely rising more than one decimeter above the ground. These are mostly found on seepage areas from melting snows, more often on slopes largely composed of disintegrated rock. The other four forms, *S. planifolia* vars. *monica* and *Nelsoni*, *S. brachycarpa* and *S. pseudolapponum* form extensive mats or thickets, 3-6 dm. high in shallow pans where the snow lies long and the growing season is very short. On northern and northwestern slopes, these mats cover many acres. These species form a striking feature of the alpine slopes, but also occur at lower altitudes.

SUBALPINE AND UPPER MONTANE

As here used this section includes a belt extending from timberline to about 9500 ft. This is the district of Engelmann spruce and subalpine fir. Within its limits are most of the mountain passes, small glacial lakes and cold bogs. These openings in the timber afford optimum conditions of moisture and light for the growth of willows. The most abundant species are the erect forms which were found on the alpine heights, *S. planifolia* vars. *monica* and *Nelsoni*, *S. pseudolapponum* and *S. brachycarpa*. All these are distinctly larger than at the higher elevations, the thickets sometimes reaching a height of a meter or more. Occurring in smaller numbers we here find *S. Wolfii*, *S. subcoerulea*, *S. monticola*, *S. pseudomonticola* and its var. *padophylla* and more rarely *S. Scouleriana*. All these added species except *S. Wolfii* are tall forms, considerably more than a meter high.

MIDDLE MONTANE

This term is used to cover the areas between 9500 and 7500 ft. The upper portion, roughly from 9500 to 8500 ft., is characterized by wider open-

ings in the timber and by moraines clothed with aspens. While Engelmann spruce still is abundant, lodgepole pine enters the picture. While bogs still occur, wet meadows and beaver pools are more characteristic. The willows of the previous section are all present, somewhat larger in size; but the proportion of the taller species increases and we add *S. ligulifolia, S. Barclayi, S. pseudocordata, S. Bebbiana,* its var. *perrostrata* and in one place *S. serissima.* The lower portion, 8500 to 7500 ft., is characterized by the presence of small

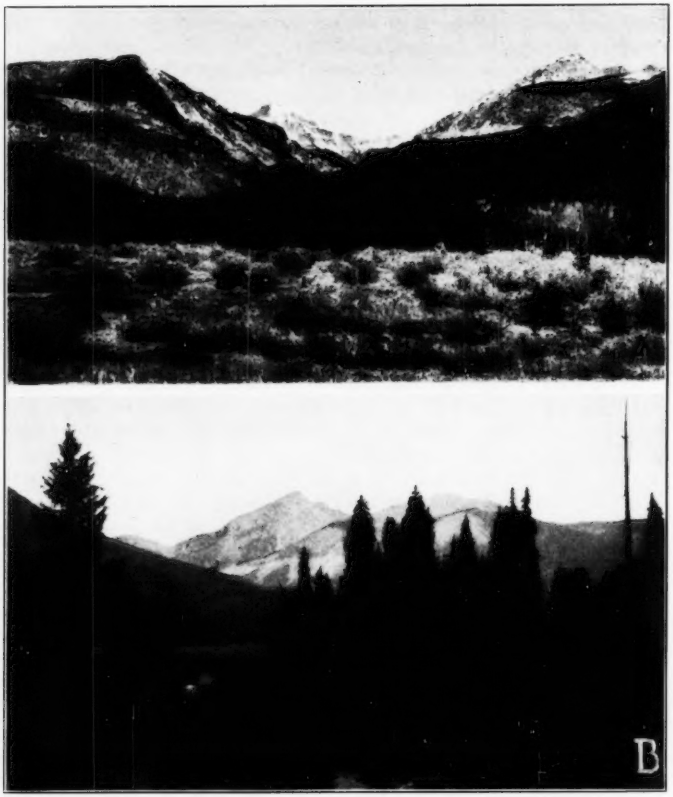


Fig. A. View across willow meadow in Middle Park, Colo. Low willows in foreground; taller species further back; Engelmann spruce bordering meadow and Never Summer Range in background.

Fig. B. Never Summer Range over willow meadow in Middle Park, Colo.; the Engelmann spruce which borders the valley bottom here projects a short distance into the meadow.

parks formed by the melting plains of retreating glaciers. Here we find the largest number of species assembled in a limited area. Hardly one of those outside the strictly alpine forms is missing, though some occur only sporadically and never in abundance. In Middle Park (8500 ft.) wide areas are covered by the lower species (mostly *S. Wolfii*), bordered by the taller *S. monticola, S. pseudomonticola* var. *padophylla, S. Geyeriana* and *S. subcoerulea*. In Estes Park (7500 ft.) the general appearance is quite different. Wide bands of willow thickets averaging 3.5 m. in height border the streams. These thickets or groves consist in the main of *S. Geyeriana,* its var. *argentea, S. Bebbiana,* its var. *perrostrata, S. monticola, S. pseudomonticola* var. *padophylla, S. caudata* and its var. *Bryantiana, S. planifolia* var. *Nelsoni* is the only alpine and subalpine form occurring in any abundance.

LOWER MONTANE

This region extends from about 7500 ft. to the plains, 5000 to 6000 ft. This is a region of rough mountain masses, cut by deep cañons. Except on steep southward facing slopes the mountains are heavily forested, with western yellow pine and limited numbers of Douglas fir and silver spruce. While some willows are found in the upper portions of the cañons, the streams for the most part are bordered by alders and birches. In the lower cañons we meet *S. irrorata* and *S. amygdaloides* for the first time, while *S. caudata* and var. *Bryantiana* appear again.

THE PLAINS

In swampy areas along the streams just outside the foothills one occasionually finds a mixture of *S. exigua* varieties, *S. caudata, S. Bebbiana, S. amygdaloides, S. ligulifolia* and a few specimens of *S. pseudomonticola* var. *padophylla.* Farther out on the palins only *S. amygdaloides* and *S. exigua* and its varieties occur.

Relationships

The forms endemic to the Rocky Mountains are *S. nivalis* var. *saximontana, S. petrophila, S. brachycarpa, S. pseudolapponum, S. Wolfii, S. monticola, S. pseudomonticola* var. *padophylla, S. irrorata* and *S. lutea.*

Those with a transcontinental distribution are *S. amygdaloides, S. Bebbiana, S. planifolia* var. *monica* and *S. serissima.*

Those common to the Rockies and Cascades are *S. Barclayi, S. cascadensis, S. exigua* varieties, *S. Scouleriana, S. Geyeriana, S. subcoerulea* and *S. caudata. S. lasiandra* extends from southern Colorado through New Mexico and Arizona to the Pacific Coast.

Flowering Habits

All Colorado willows blossom early in the season, the buds being formed during the preceding fall. The actual dates of flowering are primarily determined by the altitude. In most of the species the flowers and leaves appear

together, but in a few species this is not the case. *S. irrorata, S. subcoerulea* and *S. Scouleriana* are strictly precocious, the flowers appearing before there are any even immature leaves. On account of their distribution and certain twig characters these are easily distinguished from each other. *S. monticola, S. pseudomonticola* and its var. *padophylla* are often precocious, but in many cases a few partially developed leaves appear before the blossoming stage is past. In all cases the distinctive, if not mature, leaves are present when the capsules are ripe. This makes the identification of pistillate specimens much easier than that of the staminate ones.

In another small group the flowers do not appear until after the leaves are mature or nearly so. These are *S. nivalis* and var. *saximontana, S. cascadensis, S. petrophila* and *S. exigua* and varieties.

Hybridization

Willows hybridize rather freely. In Europe many artifiical crosses have been made, some of them between widely separated species and some of them triple crosses. In this country certain horticultural forms are known to be hybrids, the most common being derived from the introduced European species *S. alba, S. fragilis* and *S. babylonica*. M. S. Bebb crossed certain wild species at his home at Fountaindale, Illinois, and found that the forms resulting exactly matched forms occurring naturally in the wild state. Schneider lists published reports of sixty-seven different hybrids occurring naturally in American willows. Some of these are open to question and so far as reported none were subjected to the breeding test. Schneider considers one of Rydberg's specimens from Utah as a cross between *S. cordata* and *S. monticola* and a second specimen as a cross between *S. planifolia* var. *monica* and *S. subcoerulea*. In the writer's observation intermediate forms are most common in Colorado between *S. pseudolapponum* and *S. brachycarpa* and between *S. Geyeriana* and *S. petiolaris*. Strictly speaking, these are "intermediates" and that they are "hybrids" is an assumption based on the well-known tendency to hybridization in the group as a whole.

Bisexual Forms

While willows are commonly unisexual, exceptions are met with now and then. In a five years period of collecting in a rather limited area the writer has observed the exceptional condition in nine species. In two of these, *S. planifolia* var. *Nelsoni* and *S. Scouleriana* the bisexual condition was limited to single plants; in two others, *S. caudata* and *S. exigua* var. *luteosericea* the condition was present in a considerable number of specimens. In all these cases normal unisexual forms were abundant in the vicinity.

The Use of the Keys

The keys offer a choice, step by step, between contrasted characters.

Separate keys are furnished for the staminate and pistillate forms. This provides a means of identification when only one of the forms is in hand, or,

as sometimes happens, one cannot be sure that the staminate and pistillate forms under consideration belong to the same species.

Present conceptions of relationship are shown in the grouping of the species into "sections" with limited keys for each section. The listing of the section characters involves some repetition of descriptive matter, but is worth while because it brings out the common characters of the group and limits the choices to be made.

A lens of 10 magnifying power, a pair of tweezers, one or more teasing needles and a 15 millimeter measure are essential for any satisfactory work on willows.

The Descriptions

The descriptions follow a set form. This is necessary if complete comparison of characters is to be made. In all cases original descriptions and those in current manuals have been studied, but those of this paper are based upon specimens collected in Colorado. In some instances they do not wholly agree with original descriptions.

Methods of Collecting Willows

While identification of incomplete material is sometimes possible for experts, a satisfactory understanding of a species can only be gained by following it through the season, collecting flowers, fruits and mature leaves from both staminate and pistillate individuals. These mature leaves should come from both flowering branches and vigorous vegetative shoots, since the leaves on the latter often vary markedly in size and sometimes in shape from those on flowering branches. To be sure that one is dealing with the same species at these various times of collection it is necessary to attach numbered tags to the individual shrub and also to all specimens taken therefrom. Extensive collections of the same species in different localities will help to make clear the limits of variation due to ecological factors. Occasionally key characters such as "twigs with bloom" will not be present in single specimens, but may always be found if one scrutinizes a number of individuals. Frequently specimens which lack the bloom when collected develop the character after being pressed.

ACKNOWLEDGEMENTS

The manuscript was read and criticized by the author's colleagues, H. D. Harrington and Geo. H. Lane. The diagrams of aments and flower parts were contributed by Dr. L. W. Durrell.

Glossary

TERMS RELATING TO FLOWERS

Ament. The flower cluster of the willow; also called catkin.
Bisexual. Having both stamens and pistils in the same flower or on the same plant.
Caducous. Dropping off soon after formation.
Capsule. The fertilized and mature ovary, containing seeds.
Coetaneous. Blossoms opening with the leaves.
Cuneiform. Wedge shaped; tapering.
Deciduous. Falling off at end of growing period.
Dehiscence. Splitting of anther to shed pollen.
Dioecious. Stamens and pistils in flowers on different plants.
Dorsal. On the side away from the axis.

Fuscous. Grayish brown.
Glands. Small, fleshy, excreting structures at the base of each flower, but above the scales.
Monoecious. Stamens and pistils in separate flowers, but on the same plant.
Pedicel. The stalk of the ovary. When this is absent the ovary is "sessile."
Peduncle. The stem or stalk of the ament.
Pistils. These constitute the female flower. They consist of the swollen lower portion, the "ovary"; the sticky tips which receive the pollen, the stigmas; and the "style" which connects the two. When the style is absent the stigma is "sessile."
Pistillate. Containing pistils, but not stamens; applied to flowers, aments or plants.
Precocious. Blossoms opening before the leaves expand.
Reticulate. Forming a network.
Rostrate. Beaked.
Scales. Small, thin, cup-like structures below each flower of the ament.
Serotinous. Blossoms opening only after the leaves are fully developed.
Stamens. These constitute the male flower. They consist of thread-like stalks, called "filaments" and swollen tips, called "anthers" which contain pollen.
Staminate. Containing stamens, but not pistils; applied to flowers, aments or whole plants.
Unisexual. Having only staminate or pistillate flowers; applied to dioecious plants.
Ventral. On the side next the axis.

TERMS RELATING TO LEAF PARTS

Blade. The broad expanded portion of the leaf.
Petiole. The stem or stalk of the leaf.
Stipules. Small, scale-like or leaf-like organs at the base of the petiole.

TERMS RELATING TO LEAF SHAPES

Acute. Ending in a point with an angle less than a right angle.
Acuminate. Ending in a long, tapering point.
Apiculate. Ending in a minute point.
Cordate. Heart-shaped.
Elliptical. Shaped like an ellipse; longer than broad, widest in the middle, the sides curving, not parallel.
Lanceolate. Lance-shaped; narrow, broadest below the middle.
Ligulate. Strap-shaped; almost identical with oblong.
Linear. Narrow and flat, with parallel edges; like a line.
Oblanceolate. Lance-shaped; broadest above the middle.
Oblong. With parallel edges, at least 3 times as long as wide.
Obovate. Ovate, but reversed, with widest part above the middle.
Obtuse. Rounded or forming an angle of more than a right angle.
Oval. Broadly elliptical.
Ovate. Shaped like an egg; broad and widest below the middle.
Rounded. Ending in a broad curve.

TERMS RELATING TO MARGINS

Crenate. With scalloped edges.
Crenulate. With small scallops; minutely crenate.
Dentate. With upper margins of teeth projecting at right angles.
Denticulate. With smaller teeth; minutely dentate.
Entire. Without breaks in the margin.
Glandular. With glands at tips of the teeth.
Serrate. With teeth pointing forward.
Serrulate. With smaller teeth pointing forward; minutely serrate.

TERMS RELATING TO SURFACES

Appressed pubescent. With soft, short hairs pressed down parallel to the surface on which they occur.
Ciliate. Fringed with hairs, like the eyelids.
Glabrate. At first with some hairs, becoming glabrous or nearly so as the season progresses.
Glabrous. Smooth; without hairs of any kind.
Glaucous. Covered with a fine waxy powder, giving a whitish or bluish color to the surface.
Lanate. Covered with longer dense, matted, wool-like hairs.
Pilose. With long soft straight hairs.
Pruinose. Frosted; covered with a powder like hoarfrost.
Pubescent. Covered with fine, short, soft hairs.
Sericeous. With silky hairs.
Strigose. With stiff appressed hairs.
Tomentose. Covered with short, dense, matted, wool-like hairs.
Villous. Shaggy with long soft hairs.

ABBREVIATIONS USED

m. Meter; a measure 39.37 inches long; the base used in scientific measurements.
dm. Decimeter; one tenth of a meter; a little less than four inches.
cm. Centimeter; one tenth of a decimeter; a little less than 4/10 of an inch.
mm. Millimeter; one tenth of a centimeter; the unit for measuring small objects.
C.A.C. Herbarium of Colorado College of Agriculture and Mechanic Arts.
C.U. Herbarium of Colorado University.
W.U. Herbarium of Wyoming University.
C.R.B. Herbarium of Dr. Carleton R. Ball.
N.H. U.S. National Herbarium.
Jour. Journal of Arnold Arboretum.
Bot. Gaz. The Botanical Gazette.

SALICACEAE Lindl. Willow Family

Trees or shrubs with simple, alternate, usually stipulate leaves. Flowers dioecious, arranged in aments which fall off entire; the staminate after shedding their pollen, the pistillate after the ripening of the fruit and dispersion of the seeds. Bracts of the ament scale-like (Scales). Perianth none. Stamens one to many. Ovary 1-celled; stigmas two. Fruit a 2-valved capsule, inclosing many seeds, each furnished with a tuft of hairs.

Bracts lacerate; flowers in a broad or cup-shaped disk; stamens numerous; buds with several scales.....*Populus.*
Bracts entire or denticulate; flowers with 1 or 2 small glands at base; no disks; stamens few, usually 2 to 5; buds enclosed by a single scale.....*Salix.*

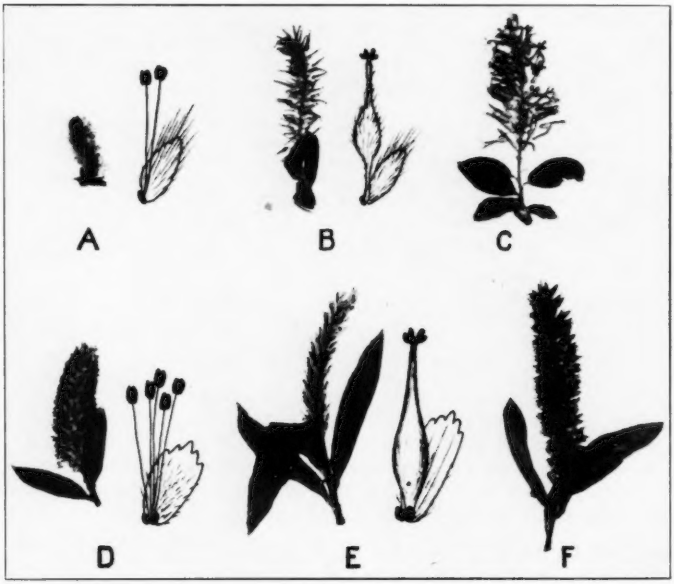
SALIX L. Willow

Trees or shrubs (mostly shrubs in Colorado); Buds covered by a single scale. Leaves mostly narrow, short-petioled. Aments mostly erect, appearing before (precocious), with (coetaneous) or after (serotinous) the leaves; scales entire or merely denticulate. Stamens usually 2-5 (7), accompanied by 1 or 2 small glands. Pistillate flowers with one or more glands at the base of the ovary when this is sessile, at the base of the pedicel when this is present; stigmas entire, notched or deeply divided.

KEY TO STAMINATE SPECIMENS

*Scales yellow or yellowish with tips of different color.

A. Stamens 3-5; scales yellow, caducous; aments on short leafy branchlets.
1. Native tree; 10-15 m. high; leaves lanceolate to ovate-lanceolate, serrate, but not glandular ..... 1. *S. amygdaloides.*
1. Shrubs 2-5 m. high; leaf margins and sometimes upper parts of petioles glandular.
2. Aments 2-4 cm. long.
3. Leaves glaucous beneath, short-acuminate..... 2. *S. lasiandra.*
3. Leaves scarcely paler beneath, long-acuminate..... 3. *S. caudata.*
2. Aments 1-2 cm. long; leaves acute to short-acuminate, pale to subglaucous beneath ..... 4. *S. serissima.*



A. Staminate ament of *S. Bebbiana* var. *perrostrata* with drawing (greatly enlarged) of a single flower showing hairy scale, one gland and two stamens consisting of filaments and anthers.

B. Pistillate ament with drawing of a single flower showing scale, long pedicel, hairy ovary with long beak and sessile stigmas.

C. Fruiting ament on short leafy peduncle.

D. Staminate ament of *S. caudata* with drawing of single flower showing scale, two glands and five stamens.

E. Pistillate ament with drawing of single flower showing scale, two glands, glabrous ovary, very short pedicel, medium style and divided stigmas.

F. Fruiting ament on short leafy peduncle.

A. Stamens 2.
4. Large introduced tree; leaves lanceolate, sharply glandular-serrate.....5. *S. fragilis.*
4. Shrubs 2-5 m. high.
5. Aments serotinous; leaves linear to linear-lanceolate.
6. Leaves pubescent on both surfaces, mostly entire.....6. *S. exigua* and varieties.
6. Leaves glabrous, at least on upper surface, denticulate.
7. Leaves glabrous on both surfaces at maturity.
8. Leaves linear-lanceolate, 6-10 cm. long, 5.10 mm. wide, remotely denticulate .....7. *S. interior.*
8. Leaves 5-8 cm. long, 2-4 mm. wide.....8. *S. longifolia* var. *pedicellata.*
7. Leaves glabrous above, thinly pubescent below, 4-10 cm. long, 2-4 mm. wide .....9. *S. melanopsis* var. *tenerrima.*
5. Aments precocious or coetaneous; leaves lanceolate or wider.
9. Filaments pilose at base.
10. Twigs with glaucous bloom.....25. *S. Geyeriana* and variety.
10. Twigs glabrous.
11. Scales yellow, tips rose-color .....26. *S. Bebbiana* and variety.
11. Scales yellow, tips brown.....27. *S. petiolaris.*
9. Filaments not pilose; scales tawny to brownish.....12. *S. lutea.*

*Scales dark brown to black.

A. Erect shrubs 1-6 m. high.
1. Flowering twigs with glaucous bloom; aments sessile.
2. Anthers yellow, rarely tinged with pink; leaves glabrous, glaucous below..... .....10. *S. irrorata.*
2. Anthers bright red; leaves silvery-silky beneath.....23. S. subcoerulea.
1. Flowering twigs without bloom (Rarely *S. planifolia* vars. have faint bloom).
3. Aments sessile or subsessile.
4. Twigs not lustrous or shining.
5. Twigs densely white-tomentose .....20. *S. candida.*
5. Twigs pubescent, puberulent, or glabrous; if glabrous, then dull ....25. *S. Scouleriana.*
4. Twigs glabrous and lustrous.
6. Leaves small, 2-5.5 cm. long .....24. vars. of *S. planifolia.*
6. Leaves larger, 5-7 cm. long.
7. Leaves oblong, oblanceolate, lanceolate-oblong (on vigorous shoots ovate or obovate) .....14. *S. monticola.*
7. Leaves narrowly to broadly ovate .....15. *S. pseudomonticola.*
3. Aments on leafy peduncles.
8. Twigs glabrous even when young.
9. Twigs dark; leaves glabrous.
10. Leaves glaucous beneath .....10. *S. ligulifolia.*
10. Leaves not glaucous, green on both surfaces .....13. *S. pseudocordata.*
9. Twigs yellowish; leaves silky-villous .....17. *S. Wolfii.*
8. Twigs and leaves pubescent or villous, especially when young.

11. Pubescence long villous, soon disappearing.
12. Aments on peduncles 1-3 cm. long ..... 16. *S. Barclayi.*
12. Aments on peduncles less than 1 cm. long or subsessile, leafy-bracted ..... 15a. *S. pseudomonticola* var. *padophylla.*
11. Pubescence shorter, denser, more permanent.
13. Aments globose; anthers subglobose ..... 19. *S. brachycarpa.*
13. Aments ellipsoid to cylindrical; anthers ellipsoid ..... 18. *S. pseudolapponum.*

A. Prostrate alpine and subalpine plants.

14. Leaves strongly reticulate, glaucous beneath.
15. Leaves elliptic, oblong-obovate or orbicular, 7-12 mm. long; aments few-flowered ..... 29. *S. nivalis.*
15. Leaves similar, but 1.5-2 cm. long; aments many-flowered ..... 29a. var. *saximontana.*

14. Leaves less distinctly reticulate, strongly-nerved.
16. Leaves 2-4 cm long, pale to subglaucous beneath ..... 21. *S. petrophila.*
16. Leaves 8-12 mm. long, green and shining on both faces..... 22. *S. cascadensis.*

KEY TO PISTILLATE SPECIMENS

*Capsules glabrous.

A. Scales pale yellow, deciduous.

1. Trees 6-20 m. high.
2. Capsules with pedicels 1.5-2 mm. long; leaves thin, without glands ..... 1. *S. amygdaloides.*
2. Capsules subsessile; glands on leaf margins ..... 5. *S. fragilis.*
1. Shrubs or small trees, not over 6 m. high.
3. Glands on leaf margins; leaves lanceolate or broader.
4. Leaves glaucous or subglaucous beneath; acute or short-acuminate.
5. Aments short and stout, not over 3 cm. long; capsules thick-walled, 7-9 mm. long ..... 4. *S. serissima.*
5. Aments 3-10 cm. long; capsules thin-walled, 5-7 mm. long ..... 2. *S. lasiandra.*
4. Leaves not much paler beneath; leaves long-acuminate, caudate ..... 3. *S. caudata* and variety.

3. No glands on leaf-margins; leaves linear to linear-lanceolate.
6. Leaves permanently pubescent on both faces, entire or rarely remotely denticulate ..... 6. *S. exigua* & varieties.

6. Leaves at length glabrous, at least on upper surface.
7. Leaves at maturity glabrous on both surfaces or nearly so, remotely denticulate to spinulosely tipped ..... 7. *S. interior.*
7. Leaves glabrous above, thinly pubescent below, spinulose tipped..... 9. *S. melanopsis* var. *tenerrima.*

A. Scales brown to black, persistent.

8. Styles 0.3-0.7 mm. long.

9. Twigs with bluish bloom.....10. *S. irrorata.*

9. Twigs glabrous, without bloom.

10. Leaves paler beneath, usually glaucous.

11. Twigs dark; leaves narrowly elliptical to lance-oblong.....11. *S. ligulifolia.*

11. Twigs yellow or reddish-brown on one side .....12. *S. lutea.*

10. Leaves not much paler beneath, not glaucous.

12. Pedicels of capsules 1-1.5 mm. long; leaves glabrous, 3-6 cm. long.....17. *S. Wolfii.*

8. Styles 1-1.5 mm. long.

13. Aments sessile to subsessile (as fruit matures a peduncle not over 0.5 mm. may develop). Leaves must be waited for.

14. Leaves oblong-lanceolate or oblong-oblanceolate .....14. *S. monticola.*

14. Leaves narrowly-to broadly-ovate.....15. *S. pseudomonticola.*

13. Aments on leafy peduncles.

15. Peduncles 1-3 cm. long; leaves ovate-lanceolate to oval or obovate.....16. *S. Barclayi.*

15. Peduncles 0.5-1.5 cm. long; leaves oval.....15a. *S. pseudomonticola* var. *padophylla.*

*Capsules hairy.

A. Styles evident, 0.5-2 mm. long.

1. Aments on leafy peduncles.

2. Erect alpine or subalpine plants 3-10 dm. high.

3. Aments globose to elliptical; capsules 3-5 mm. long; petioles not longer than buds .....18. *S. pseudolapponum.*

2. Creeping alpine plants less than 1 dm. high.

4. Aments 2-4 cm. long, many-flowered; leaves 2-4 cm. long, paler beneath.....21. *S. petrophila.*

4. Aments 0.7-2 cm. long, few-flowered; leaves 1-1.2 cm. long, green and shining on both sides .....22. *S. cascadensis.*

1. Aments sessile.

5. Twigs pubescent or tomentose .....20. *S. candida*

5. Twigs glabrous or with bluish bloom.

6. Twigs with bloom; leaves glabrous above, densely silvery-silky beneath.....23. *S. subcoerulea.*

6. Twigs glabrous, sometimes with faint bloom; leaves glabrous, glaucous beneath .....24. vars. of *S. planifolia.*

A. Styles obsolete or very short, not over 0.3 mm.

7. Tall, erect shrubs.

8. Scales black; pedicels short; stigmas long .....25. *S. Scouleriana.*

8. Scales yellowish, sometimes with darker tips.

9. Capsules 4-6 mm. long; leaves narrow, lanceolate.

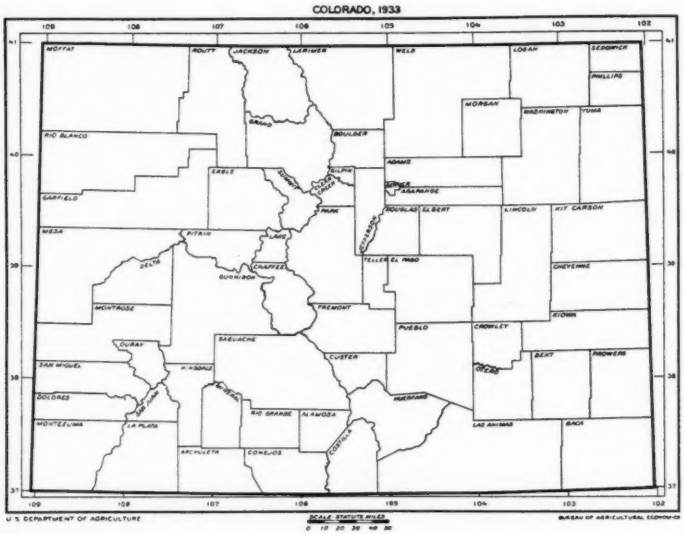
10. Twigs with bloom; leaves entire .....28. *S. Geyeriana.*
10. Twigs without bloom; leaves sharply serrate .....27. *S. petiolaris.*

9. Capsules 6-9 mm. long; leaves narrowly elliptical to broadly oblanceolate or obovate-oval .....26. *S. Bebbiana* and variety.

7. Creeping alpine plants only a few cm. high.

11. Aments 3-6 flowered, 1 cm. or less long; leaves 0.7-1.2 cm. long ..... 29. *S. nivalis.*

11. Aments many-flowered, 1-3 cm. long; leaves 1.5-2.5 cm. long ..... 29a. var. *saximontana.*



AMYGDALINAE Koch, Salic. Eur. Comment. 17. 1828. (*Triandrae* Dumortier.)—Trees 3-15 m. high; bark brown, twigs long and slender, often drooping, the youngest yellow: leaves linear-lanceolate to broadly-lanceolate, acuminate, closely and finely serrulate, glabrous; stipules small and deciduous or none; aments coetaneous, slender, cylindrical, terminal on lateral leafy twigs; scales deciduous, light yellow, lanceolate or broader, mostly glabrous outside, crisp-villous within: stamens 3-7, filaments hairy below: capsules small, glabrous, pedicellate; styles 0.3-0.5 mm. long; stigmas short.

1. SALIX AMYGDALOIDES Anders. Oefv. Svensk. Vet.-Akad. Foerh. 15: 114. 1858.—A tree 3-15 m. high, the twigs gray or the youngest yellow: leaves lanceolate to ovate-lanceolate, acuminate, (frequently broadly oblanceolate or obovate and obtuse when unfolding), base acute to rounded, margin finely serrulate; green above, glaucous beneath; mature leaves 5-10 cm. long, 2.5-3 cm. wide; on vigorous shoots ovate, up to 16 cm. long, 6 cm. wide;

petioles slender, 2-3 cm. long: aments appearing with the leaves; scales light yellow, ovate, crisp villous on margins and inside; staminate aments 3-5 cm. long, 1 cm. wide, stamens 3-5, hairy at base; pistillate aments lax in fruit, 4-8 cm. long; capsules glabrous, lanceolate to ovoid, 4-5 mm. long; pedicels slender, 1.5-2 mm. long; styles 0.3 mm. long; stigmas short, bifid. The common tree willow along streams in the cañons and out on the plains.

C. A. C. Larimer Co., Along Cache la Poudre River; Las Animas Co., Trinidad. Boulder Co., So. St. Vrain Cañon; Pueblo Co., near Pueblo; Huerfano Co., LaVeta.

1a. f. PILOSIUSCULA Schn. Jour. 1:11. 1919.—This form differs from the type by twigs and young leaves pilose (rarely the petioles and midribs of the leaves tomentose), branches of the second year yellowish and aments denser, fruits closer together.

Schneider. Larimer Co., Clear Creek Co., Las Animas Co., Montrose Co., Morgan Co. and Weld Co.—C. A. A. Larimer Co., Rist Cañon, along Cache la Poudre River.

This is a "form" rather than a variety, a series of specimens showing gradual gradations in the amount of pubescence.

1b. f. **angustissima,** f. nov.—A planta typica foliis lineari-lanceolatis differt. Common on the sandbars of the Cache la Poudre River in the eastern part of the state.

C. A. C. Weld Co., 30 miles east of Greeley.

PENTANDRAE Dumortier, Bijdr. Natuurck. Wetensch. 58:1825.—Tall shrubs or small trees (in our range) with sparingly caespitose stems, 3-6 m. high, bark reddish-brown; twigs and obtuse buds stouter than in Amygdalinae, olive to reddish-brown, lustrous: leaves large, lanceolate or elliptical, acute to long-acuminate, closely glandular-serrate especially near the base, glabrous; petioles stout, glandular or naked; stipules small or none: aments coetaneous, dense, oblong, on short lateral leafy twigs; scales pale yellow, deciduous, lanceolate to obovate, thinly pilose at the base; capsules rather large, 5-9 mm. long, glabrous; pedicel 1-2 mm. long; styles 0.5 mm.; stigmas short, notched or bifid.

Fruiting in early summer; capsules thin-walled, 5-7 mm long.
Leaves short-acuminate, glaucous beneath ..... 2. *S. lasiandra.*
Leaves long-acuminate, scarcely paler beneath ..... 3. *S. caudata.*

Fruiting in late summer; leaves subglaucous, at least much paler beneath; capsules thick-walled, 7-9 mm. long ..... 4. *S. serissima.*

2. SALIX LASIANDRA Benth. Pl. Hartweg. 335. 1849.—A small tree within our limits; twigs rather stout, deep red, lustrous: leaves lanceolate to broadly-lanceolate or sometimes oblanceolate, acuminate at the apex, acute to rounded at the base, dark green and shining above, glaucous beneath, 6-10 cm. long, 1.5-3.5 cm. wide; stipules small, acute, glandular: aments on peduncles 1-6 (usually 2-3) cm. long; the staminate 2-6 cm. long, 1-1.3 cm. wide; the pistillate 3-10 cm. long, 1.2-2 cm. wide; scales lanceolate to ovate, sometimes glandular at the apex; capsule pale straw-color or light brown, lanceolate, 5-7

mm. long; pedicel 1.5-2 mm. long; style 0.5 mm. long; stigmas short, bifid. This species occurs only in the southwestern part of the state, having been reported from Archuleta Co. (Piedra) by C. R. B. and N. H. and from Montrose Co. (Cimarron) and San Miguel Co. (Norwood Hill) by N. H.

3. SALIX CAUDATA (Nutt.) Heller, Muhlenbergia 2:116. 1906 (*S. Fendleriana* Anders.) (*S. lasiandra* var. *caudata* (Nutt.) Sudw.)—A shrub 2-4 m. high; twigs long, but not slender, shining, reddish or reddish-yellow; leaves of two distinct shapes; the commoner narrowly-lanceolate to lanceolate or oblanceolate, the less common ovate-lanceolate to ovate, found on vigorous sterile shoots; both forms have long-acuminate tips, rounded to acute bases, glandular-serrate margins, glabrous faces, the lower face somewhat paler, but oblanceolate, the less common ovate-lanceolate to ovate, found on vigorous shoots 12 cm. long, 3-4 cm. wide; on base of flowering twigs 2-3.5 cm. long, 1 cm. wide; petioles very short, pubescent, as are the flowering twigs; stipules when present small, lanceolate to reniform, glandular-serrate: staminate aments 3-4.5 cm. long, 1-1.5 cm. wide; pistillate aments 3-6 cm. long, 1-1.5 cm. wide; scales lanceolate, oblanceolate or obovate, obtuse; capsules straw-colored, 5-7 mm. long; pedicels 1-1.5 mm. long; styles 0.5 mm. long; stigmas notched.

A cluster of shrubs of this species under observation for four consecutive years maintained a bisexual condition. A few aments were wholly staminate or wholly pistillate, but the majority bore both kinds of flowers. While in general the staminate flowers occurred at the tip of the ament, occasionally the positions were reversed or the staminate flowers were scattered indiscriminately in the ament.

C. A. C. Larimer Co., La Porte (5069 ft.), Estes Park Entrance (7500 ft.); Jackson Co., North Park, Walden (8050 ft.), Murphy's Ranch (8200 ft.); Routt Co., Steamboat Springs (6762 ft.), Yampa (7884 ft.).—C. R. B. El Paso Co., Colorado Springs (5978 ft.) W. U. Conejos Co., Los Pinos (9625 ft.), Ojo; Tabegauche Basin. N. H. Douglas Co., Winkler Ranch.

3a. var. BRYANTIANA Ball and Bracelin, Jour. Wash. Acad. Sci. 28:445. 1938.—Differs from the type by branchlets and petioles glabrous, either from the beginning or very soon after the leaves appear and by the presence with mature leaves of stipules which are markedly glandular-margined. This form seems to be more common than the type in Colorado.

C. A. C. Grand Co., Grand Lake (8153 ft.); Jackson Co., North Park (8000 ft.); Larimer Co., La Porte (5069 ft.), Bellevue (5100 ft.), Rist Cañon (6000 ft.), Estes Park (7580 ft.); Routt Co., Steamboat Springs (6762 ft.), Yampa (7884 ft.).—C. R. B. Alamosa Co., Alamosa (7500 ft.); Del Norte Cos, Del Norte; El Paso Co., Colorado Springs (5900 ft.); Gunnison Co., Gunnison (6500 ft.), Mt. Carbon; Las Animas Co., Stonewall (5900 ft.); Douglas Co., Sedalia (5837 ft.); Rio Grande Co., Monte Vista (7500 ft.); Costilla Co., San Acacia.—N. H. Conejos Co., Los Pinos (9625 ft.); Moffatt Co., Henry Fork of Green River; Montezuma Co., Mancos (6996 ft.).—W. U. Eagle Co., State Bridge; Conejos Co., North of Antonito.

4. SALIX SERISSIMA (Bailey) Fernald, Rhodora 6:6. 1903. — In our district a shrub 1-3 m. high; stems light gray, branches light tan, ultimate twigs lustrous reddish-brown, in sharp contrast to the branches; leaves elliptical-

lanceolate, varying to lanceolate or oblanceolate, 4-6.5 cm. long, 1-2 cm. wide (on late season vigorous shoots up to 8 cm. long); acute to acuminate apex, cuneiform base, margin minutely glandular-serrulate, dark green and shining above, subglaucous beneath, midrib whitish; petioles more slender than in related species: aments very short and stout; the staminate 1-2 cm. long, 1-1.2 cm. wide; the pistillate 1.5-3.5 cm. long, 2 cm. wide; scales broad, obtuse, green at first, later pale yellow, notched or dentate at the tips, sometimes glandular: capsules lustrous, long-conic, thick-walled, at maturity olive-brown to deep reddish-brown, at least on one side, 6-8 (9) mm. long; pedicels thick, 1-1.5 cm. long; style very short (0.3 mm.); stigmas notched. Autumn Willow.

This species, so far as is known, has been reported from only one station in Colorado, — the willow meadows near Long's Peak Inn. Francis W. Hunnewell of Wellesley, Mass., reported it from this Station in Rhodora 25:67. 1923. Recently the writer has obtained abundant specimens of both staminate and pistillate plants from the same area. The contrasting colors of branches and twigs, the sharp angle at which the branches diverge from the main stems and the frequently almost globular pistillate aments sharply distinguish this species from others in the section.

C. A. C. Larimer Co., Longs Peak Inn. (9000 ft.).

ALBAE Borrer, Hook. Brit. Fl. 418. 1830.—Large introduced trees, several species of which have become well established in the United States, one species only in Colorado. Trunks reaching a diameter of 3-4 ft., bark brown, broken into plates: leaves lanceolate to ovate-lanceolate long-acuminate, serrate: aments 2-5 cm. long; scales yellow, deciduous; filaments hairy below; capsules glabrous, sessile or subsessile.

5. SALIX FRAGILIS L. —A tree 20-25 m. high; trunk reaching 10-12 dm. in diameter: leaves (mature) lanceolate or broadcast at the middle, long-acuminate, base acute, margin rather coarsely serrate (5-6 teeth to the cm.), glabrous, green on both sides, but paler beneath; 10-15 cm. long, 2.5-4 cm. wide; petioles, where they join the leaf blades and leaf-margins at the base glandular; stipules when present small, semi-cordate: aments slender; the staminate 3-5 cm. long; the pistillate 5-7 cm. long; capsules subulate-conical, glabrous, 5 mm. long, short pedicelled; stigmas notched, nearly sessile.

Rather generally distributed as a street tree in the cities of eastern Colorado and established along the Cache la Poudre River above Bellevue and in Buckhorn Cañon.

C. A. C. Fort Collins, Greeley, Boulder.

LONGIFOLIAE Andersson. Sal. Bor. Am. 1857-1860.—Shrubs 2-5 m. high, with densely caespitose stems and gray or light brown bark; twigs slender, brown or reddish, often lustrous: leaves linear to linear-lanceolate or narrowly elliptical, entire or remotely denticulate; petioles very short; stipules none: aments serotinous, terminating lateral leafy branches, the staminate often, and the pistillate occasionally in pairs or threes; scales light yellow, deciduous:

stamens 2, filaments hairy below: capsules glabrous to thinly villous, 4-7 mm. long: styles none; stigmas short, divided (in our species.)

Leaves permanently pubescent on both sides, mostly entire, but sometimes remotely denticulate.

Pubescence short, appressed, leaves at maturity gray or green, dull; aments dense, ovaries sessile or nearly so ..... *S. exigua.*

Pubescence more silvery; aments looser; ovaries short-pedicelled .....var. *stenophylla.*

Pubescence more villous, longer, and silvery appearance enduring longer than in stenophylla ..... var. *luteosericea.*

Leaves when mature glabrous or nearly so, at least on upper surface.

Leaves at maturity glabrous or nearly so on both surfaces.

Leaves linear-lanceolate, 6-10 cm. long, 4-10 mm. wide, remotely dentate..... ..... *S. interior.*

Leaves linear, 6-8 cm. long, 2-4 cm. wide, denticulate; veins prominent ....*S. longifolia* var. *pedicellata.*

Leaves at maturity glabrous above, but thinly pubescent beneath, veins impressed..... ..... *S. melanopsis* var. *tenerrima.*

6. SALIX EXIGUA Nutt., Sylva 1:75. 1842.—A shrub or small tree 2-6 (7) m. high; twigs yellowish or light brown, silky-pubescent when young: leaves linear to narrowly linear-lanceolate, mostly entire, but sometimes remotely denticulate, appressed-pubescent with very short hairs, silvery at first, then dull, pubescence hardly noticeable without lens; petioles very short: aments on leafy branches 2-5 cm. long; scales light yellow, lanceolate, acute, pilose at base and on inner side; gland 1 in staminate blossom; staminate aments 2-5 cm. long; 5-7 mm. wide; pistillate aments 3-10 cm. long, 6-8 mm. wide, rather dense: capsules elongate-ovate, pubescent when young, nearly glabrous when mature, subsessile; stigmas sessile, short, bifid. The commonest "Sandbar Willow" of the state, occurring in the cañons up to 7500 feet and extending out on the plains to the eastern boundary and into Nebraska and Kansas. At maturity it is distinguished from the varieties by its dull, opaque surface.

C.A. C. Denver Co. Denver (5216 ft.); Garfield Co., Glenwood Springs (5147 ft.); La Jara Co., Villa Grove; Larimer Co., along Cache la Poudre River, Rist Cañon, Big Thompson Cañon, Estes Park (7500 ft.).—C. R. B. Archuleta Co., Piedra; Delta Co., Delta (4980 ft.); El Paso Co., Black Forest, Green Mountain, Manitou; Las Animas Co., Stonewall; Routt Co., Routt National Forest.—W. U. Alamosa Co., Alamosa (7500 ft.); Rio Grande Co., Monte Vista (7500 ft.) N. H. Conejos Co., Los Cinos (9625 ft.); Las Animas Co., Trinidad (5999 ft.); Eagle Co., Wolcott.

6a. var. STENOPHYLLA (Ryd.) Schn. Bot. Gaz. 65:25.—This differs from the type by the permanent silky canescence of the leaves, especially on the under side, and by the somewhat shorter leaves, those of the fertile branchlets linear-lanceolate, and by the longer pedicels of the capsules.

C. A. C. Alamosa Co., Alamosa (7500 ft.); Larimer Co., La Porte (5065 ft.), Estes Park (7500 ft.).—C. R. B. Lake Co., (9558 ft.); Montezuma Co., Dolores (6957 ft.); Rio Grande Co., Monte Vista (7500 ft.).—N H. Larimer., Big Thompson Cañon; Montrose Co., Bedrock.

6b. var. LUTEOSERICEA (Ryd.) Schn. Bot. Gaz. 67:334.—This differs from the type in its more permanently visible pubescence which is silvery; and from var. *stenophylla* by its more villous pubescence and its looser aments on shorter peduncles.

C. A. C. Larimer Co., La Porte, 2 m. above Bellevue on bank of Cache la Poudre River (5100 ft.), Rist Cañon (5400 ft.), Big Thompson Cañon; Conejos Co., north of Antonito; Elbert Co., Elizabethtown; County unknown, Walton Creek.

Several shrubs of this variety near the banks of the Cache la Poudre River were observed to be in the bisexual condition. Differing from the state as noted in other species, the pistillate flowers were situated at the tip in most of the aments and no wholly pistillate and only a few wholly staminate aments were seen.

7. SALIX INTERIOR Rowlee, Bull. Torr. Bot. Club 27:253. 100.—A shrub 1-4 m. high; twigs slender, ascending; leaves linear-lanceolate to linear-oblong, tip very acute, often cuspidate, base narrowly cuneate, margin usually remotely but distinctly denticulate, the teeth sometimes spinulose, the very young twigs and leaves silky-pubescent, the mature leaves glabrate, 6-10 cm. long, 5-10 mm. wide, pure green and veiny on both sides; petioles 3-8 mm. long: aments on leafy branches sometimes 15 cm. long; the staminate 2-4 cm. long, the pistillate 2-4 (5) cm. long; scales ovate to obovate (rarely oblong), glabrous or hairy towards the base; ovaries appressed-silky, capsules glabrous, 5-7 mm. long, long-conic, blunt at tip; stigmas large, sessile.

C. A. C. Fort Collins (5000 ft.), Cache la Poudre River towards the foothills (5200 ft.), Big Thompson Cañon (6000 ft.).—C. R. B. Prowsers Co., Lamar (3500 ft.).—N. H. Crowley Co., Limon Junction (5280 ft.).

8. SALIX LONGIFOLIA var. PEDICELLATA Anders.—Differs from the type in the narrower leaves, 3-5 mm. wide, and the longer pedicels of the capsules.

C. A. C. El Paso Co., Colorado City (5950 ft.), Manitou (6200 ft.), Ute Pass (7200 ft.), Ruxton Creek (7500 ft.); Jefferson Co., Bear Creek (7200 ft.).

9. SALIX MELANOPSIS var. TENERRIMA Ball, Proc. Nat'l Acad. Sci. 21(4): 181-186.—A low shrub with dark red, lustrous bark on branchlets; leaves 4-8 cm. long, 2-4 mm. wide, linear, remotely denticulate, especially towards the tip, which is minutely spinulose and dark colored, glabrous above, thinly pubescent beneath (under lens), veins slightly impressed, (on vigorous shoots the leaves may be 11-14 cm. long, 7-12 mm. wide); aments slender, 3-4 cm. long, the staminate 5-6 mm. wide, the pistillate 7-8 mm. wide; capsules ovate-lanceolate, glabrous, 4-5 mm. long; pedicels 0.51-1 mm. long.

This is *S. tenerrima* of Heller, *S. linearifolia* of Rydberg (in part) and *S. exigua* var. *tenerrima* of Schneider.

C. A. C. North Park, Jackson Co. (8600 ft.).

CORDATAE Barratt in Hook. Fl. Bor.-Am. 2:149. 1838. — Shrubs 2-5 m. high; stems densely caespitose; twigs brown to yellow, mostly slender,

lustrous: leaves linear-lanceolate to ovate or broadly oblanceolate, acute to long-acuminate, stipulate, glabrous; buds and slender petioles yellowish: aments precocious or coetaneous, rather slender, subsessile or on short, bracted peduncles; scales tawny to fuscous: capsules glabrous, pedicellate; styles distinct, less than 1 mm. long, except in *S. pseudocordata*.

Leaves glaucous or distinctly paler beneath.
  Leaves linear-oblanceolate; twigs with bloom ..... *S. irrorata.*
  Leaves lanceolate or broader; twigs without bloom.
    Twigs dark brown; leaves strap-shaped ..... *S. ligulifolia.*
    Twigs yellow, reddish-brown on one side; leaves lanceolate to ovate-lanceolate ..... *S. lutea.*
Leaves green on both sides, not glaucous ..... *S. pseudocordata.*

10. SALIX IRRORATA Anders. Oefv. Handl. Vet. Akad. 15:17. 1858.—Shrub 2-3 m. high; twigs dark brown to yellowish, glabrous or downy-puberulent at first, usually covered with a bluish glaucous bloom (if not present when twigs are collected this bloom frequently appears after specimens are pressed): buds stout, broadly ovate, color same as that of the stem: leaves mostly linear-oblanceolate, varying to oblong-oblanceolate or linear-lanceolate, 6-10 cm. long, 0.7-1.7 cm. wide, acute to acuminate at both ends, entire or undulate-serrate, glabrous, dark green and veiny above, with whitish midrib prominent, glaucous beneath; stipules none; aments precocious, sessile; the staminate aments 1-2 cm. long, stamens 2, filaments glabrous, anthers often red-tipped before opening; the pistillate 2-4.4 cm. long, 7-10 mm. wide, densely flowered; capsules ovate-conic, 3-4 mm. long, subsessile, glabrous; styles 0.5-0.7 mm. long; stigmas short, entire or emarginate. Common along streams from the plains to an elevation of 7500 ft.; the earliest blossoming willow of the lower cañons, showing its "pussies" in March and blossoming from mid-April.

C. A. C. El Paso Co., So. Cheyenne Cañon, Monument (6930 ft.); Boulder Co., So. St. Vrain Cañon (6500 ft.); Larimer Co., Rist Cañon (5600 ft.), Big Thompson Cañon, Poudre Cañon.—C. R. B. Jefferson Co., Turkey Creek Cañon; El Paso-Teller Cos., Pike's Peak (6800 ft.).—N. H. Conejos Co., Los Pinos (9625 ft.).

11. SALIX LIGULIFOLIA Ball, (*S. lutea* var. *ligulifolia* Ball) Bot. Gaz. 71:428. 1929. — Shrub 2-3 m. high; twigs usually dark brown, glabrous, usually shining, or youngest pubescent: mature leaves ligulate or oblong-lanceolate (narrowly oblanceolate when young), 5-7 cm. long, 1-1.5 cm. wide, (on vigorous sterile shoots up to 12 cm. long, 3 cm. wide), acute or short-acuminate tip, rounded or subcordate base, margin entire or shallowly serrulate, dark green above, pale and white-glaucous beneath, reticulate on both sides; petioles 1-1.5 cm. long; stipules semicordate and acute to semilunate and obtuse: aments coetaneous or somewhat precocious; scales elliptic-oblong to obovate, the upper half to two-thirds a dark purplish-brown, drying black, the lowest third greenish, covered with long whitish, crinkly hairs; staminate aments 2-3 cm. long, 7-9 mm. wide; pistillate 2-3.5 (4) cm. long, 1 cm. wide, subsessile to peduncles 1.2 mm. long; capsules lanceolate to lance-ovoid,

glabrous; styles 0.2-0.5 mm.; stigmas dark purple, bifid; pedicels 2-2.5 mm. long.

C. A. C. Larimer Co., banks of Cache la Poudre River (LaPorte (5100 ft.) Bellevue, Greeley).—C. R. B. Boulder Co., Gillham's Gulch (9150 ft.); Costilla Co., Blanca (7750 ft.); El Paso Co., Beaver Creek, 3 m. sw. Monument (5600 ft.); El Paso-Teller Cos., Pike's Peak (6250 ft., 6750, 6800, 7000, 7200, 9100, 9500 ft.); Teller Co., Creek east of Divide; Gunnison Co., Anthracite Creek (8800 ft.); Las Animas Co., Stonewall; Rio Grande Co., Monte Vista (7550 ft.), Rio Grande (7650 ft.); Sagauche Co., Cochetopa Nat. For. (9500 ft.).—N. H. Conejos Co., Los Pinos (9625 ft.); Park Co., Cassells.

12. S. LUTEA Nutt., N. Am. Sylva 1:63. 1842.—Shrubs 2-5 m. high; twigs mostly yellow, reddish-brown on the sunny side, glabrous to puberulent: leaves lanceolate to ovate-lanceolate, acute to short-acuminate at the tip, rounded to cordate at the base, 4-8 (10) cm. long, 1.5-4 cm. wide, entire to serrulate, mostly yellowish-green, glaucous beneath; stipules ovate to lunate, entire to serrulate: aments nearly sessile, on very short, bracted peduncles; the staminate 2-3 cm. long; pistillate 2-4 cm. long, 1 cm. wide; scales oblanceolate, acute to obtuse, tawny, thinly pilose; capsules ovate-conic, 4 mm. long, glabrous; pedicels 0.7-2 mm. long; styles less than 0.5 mm. long. Western Yellow Willow. Rare in the state.

C. A. C. El Paso Co., Palmer Lake (7237 ft.); Douglas Co., Garber Creek.—C. R. B. El Paso Co., Black Squirrel Creek; Teller or El Paso Cos., Bear Creek (7200 ft.), Pike's Peak (8000 ft.).

13. SALIX PSEUDOCORDATA (Anders.) Rydb., Fl. Col.; 94. 1906.—A shrub 2-5 m. high; twigs slender, mostly short, divaricate, leafy, bright chestnut to dark brown, lustrous: leaves oval-oblong, elliptic-oblanceolate to obovate or oblanceolate, acute to acuminate tip, mostly rounded at base, 3-6 cm. long, 1-2 cm. wide, subentire or shallowly glandular-serrulate, dark green above, pure green (not much paler) beneath, coarsely reticulate with broad veins; petioles 3 8 mm. long, glabrous or thinly villous; stipules lanceolate to ovate, acute to acuminate, glandular-serrate, 4-8 mm. long: aments precocious or subcoetaneous, 2-3 cm. long in both sexes; scales oblong or oblanceolate, acutish to truncate, thinly clothed with long white, woolly hairs; capsules greenish, 4-5 mm. long; styles 1-1.25 mm. long, stigmas thick, entire; pedicels 1-1.5 mm. long.

C. A. C. Larimer Co., Bear Lake (8985 ft.); Jackson Co., North Park (8400 ft.); Routt Co., Steamboat Springs (6700 ft.).—C. R. B. El Paso Co., Black Squirrel Creek, Bohart Ranch; Grand Co., Grand Lake (8369 ft.); Cochetopa Nat. For. (9000 ft.); Lake Co., between Twin Lakes and Leadville (9500 ft.); Routt Co., Yampa (7884 ft.).

COMMUTATAE Ball, in Coulter and Nelson, Manual. 1909. (*Adenophyllae* Schneider, Ill. Handb. Laubholzk. 1:52. 1904).—Shrubs 1-4 m. high; stems densely cespitose; twigs lustrous, light yellowish-green to dark purplish brown: leaves ovate-lanceolate, ovate, oblanceolate, elliptic-oval, or obovate, entire or shallowly serrulate, from glabrate to villous-tomentose, at least above on mature leaves, stipulate: aments from subsessile to leafy-pedunculate, precocious or

coetaneous; scales dark brown to black, obtuse, villous; capsules ovate or rostrate, glabrous or thinly sericeous; pedicels 0.5-1.5 mm. long; styles 1-1.5 mm. long.

Aments sessile or subsessile.

Leaves oblong, lance-oblong, or oblanceolate ..... *S. monticola.*
Leaves elliptic-ovate to broadly ovate ..... *S. pseudomonticola.*

Aments at maturity definitely peduncled.

Peduncles short, in fruit 0.5-1.5 cm. long ..... *S. pseudomonticola* var. *padophylla.*
Peduncles 1-3 cm. long ..... *S. Barclayi.*

14. SALIX MONTICOLA Bebb. Coulter's Manual, 336. 1885.—Shrub 3-6 m. high; stems ashy-gray up to last two divisions, the penultimate divisions often tan color, the ultimate twigs at time of flowering usually yellowish or greenish-yellow, but sometimes purplish-brown: buds large, 1 cm. long, beaked: leaves oblanceolate to obovate when young, mature leaves commonly oblong-oblanceolate, but varying to broadly oval or even obovate, acute or short-acuminate at tip, narrowed and rounded at base, or even subcordate on large leaves of vigorous sprouts, margin unevenly crenate-serrulate; glabrous, dark green above, pale to glaucous beneath; average size 5-7 cm. long, 2-4 cm. wide, on vigorous shoots 8-10 cm. long, 4 cm. wide; stipules large, ovate or semicordate, caducous: aments densely flowered; scales black, obovate-oval to orbicular, obtuse, densely villous with white hairs longer than the scale; staminate aments 2-3 (5) cm. long, 7-10 mm. wide, sessile, usually without bracts; pistillate aments in fruit 3-6 cm. long, 1-1.5 cm. wide, sessile to subsessile, or with peduncle 4-6 mm. long, beset with leaf-like bracts; capsules glabrous, sessile or subsessile, rostrate, 5-7 mm. long; styles 1-1.5 mm. long; stigmas short, bifid or entire.

The commonest willow at middle elevations, from the lower cañons (5000 ft.) to the mountain parks (7000-9000 ft.). It is more often precocious, but sometimes the leaves issue with the flowers, which come in early May. In the field it is most easily recognized by the strikingly light color of the twigs. These usually turn dark in drying. This accounts for previous descriptions of the twigs as "deep reddish-brown."

C. A. C. Boulder Co., No. and So. St. Vrain Cañons; Grand Co., Grand Lake (8369 ft.); Jackson Co., North Park (8200 ft.); Larimer Co., Big Thompson Cañon, Poudre Cañon, Rist Cañon, Estes Park (7500 ft.); Routt Co., Steamboat Springs (6762 ft.).—C. R. B. Boulder Co., Ward (9150 ft.); Clear Creek Co., near Georgetown (8640 ft.); Douglas Co., Garber Creek, S. W. of Sedalia; Eagle Co., White River Forest (8000 ft.); El Paso Co., Pike's Peak (8300 ft., 8250, 8400, 8800, 9100, 9300 ft.); Jefferson Co., Mountains near Golden (photograph of the type specimen); Lake Co., Malta (9000 ft.), Leadville (10,200 ft.); Larimer Co., Glen Haven (6500 ft.), Cache la Poudre River, Buckhorn Ranger Station (8300 ft.); Mesa-Montrose Cos., Uncompahgre Plateau, Dry Creek, Spruce Lodge; Ouray Co., Mt. Ouray; Ouray-Montrose Boundary, McKenzie Creek; Teller Co., Divide, Woodland Park, No. branch Catamount Creek (4900 ft.).—N. H. Chaffee Co., Buena Vista (8000 ft.); Clear Creek Co., Georgetown (8640 ft.); El Paso Co., Green Mountain Falls

(7500 ft.), 2 miles So. of Monument (6958); Gunnison Co., Mt. Carbon (9000, 9200 ft.); Hinsdale Co., Carson; Conejos Co., Los Pinos (7000 ft.); Monterey-La Plata Cos., Bob Creek (10,000 ft.); Park Co., Cassells; Rio Blanco Co., Book Plateau; San Juan Co., Silverton (10,500 ft.); San Juan-Dolores Co., Saddleback Mt. (8500 ft.).

15. SALIX PSEUDOMONTICOLA Ball, Flora Glacier National Park.—Shrub 1-5 m. high; branchlets divaricate, the younger pubescent or glabrate: leaves stipulate, slender-petioled, elliptic-ovate or broadly oblong-ovate to broadly ovate, 4-7 cm. long, 1.8-3 cm. wide (on vigorous shoots up to 10 cm. long, 4-5 cm. wide), rounded or mostly cordate at base, acute to abruptly short-acuminate at tip, coarsely glandular crenate-serrate, veiny, glabrous, glaucous beneath: aments coetaneous, sessile to subsessile, bracted at the base, the staminate 2.5-3 cm., the pistillate 3-7 or sometimes up to 10-12 cm. long; scales brown, clothed with white hairs; stamens 2, filaments glabrous, distinct; capsules 6-8 cm. long, glabrous; pedicels 1.5-2.5 mm. long, styles 0.8-1.3 mm. long. Vigorous blades of leaves often with a small lobe or large tooth on either side. Leaves openly, but delicately reticulate above, the yellowish midrib and primary veins below prominently elevated, the cross veinlets finely plane-reticulate.

C. A. C. Grand Co., Grand Lake (8369 ft.); Larimer Co., Estes Park (8000 ft.). —C. R. B. Archuleta Co., Piedra; El Paso or Teller Cos., Pikes Peak Region, east of Manitou (6412 ft.); Lake Co., Lake Creek Cañon; Routt Co., Yampa (7884 ft.).

15a. var. PADOPHYLLA (Rydb.) Ball, Jour. Wash. Acad. Sci. 28:450. 1938.—Shrub reaching a height of 5 m., with light brown smooth bark, branches mostly ashy-gray, ultimate twigs yellowish or sometimes brown to purple: leaves oval, tips acute or sometimes short-acuminate, base rounded to subcordate, margin crenate to crenulate, when young sparingly hairy, soon glabrate above, glaucous beneath; 3.5-6 cm. long, 2-3 cm. wide (on vigorous shoots up to 9 cm. long, 4 cm. wide, with cordate base and acuminate tip); petioles 5-10 mm. long: staminate aments subsessile, 2-3 cm. long, 10-12 mm. wide, subtended by a few leaf-like bracts 2.5-3 cm. long, scales dark brown, clothed outside with soft white, crisp hairs twice the length of the scale, glabrous within; pistillate aments 3-4 cm. long, 1-1.5 cm. wide, densely flowered, usually appearing before the leaves, borne on leafy peduncles which at first are very short, but in fruit become 1.5-2 cm. long, the leaves on the peduncles true leaves with glandular-margined stipules; pistils slender and green when young, and often subsessile; the mature capsules ovoid-conic, 5-6 mm. long, with pedicels 0.5-1.5 mm. long; styles 1.5 mm. long; stigmas 2, deeply cleft.

This form has been confused with the species and with *S. monticola,* but comparison of numerous specimens of all three make clear distinctions possible. Both *S. monticola* and *S. pseudomonticola* characteristically have sessile aments, while *padophylla* has short leafy peduncles. *S. monticola* has oblong-lanceolate or oblong-oblanceolate leaves on flowering branches; *S. pseudo-monticola* has prevailingly ovate leaves; var. *padophylla* oval leaves. As now understood this form is abundant and widely distributed in the state.

C. A. C. Larimer Co., Estes Park (7500 ft.); Grand Co., Grand Lake (8500 ft.). —C. R. B. Conejos Co., Los Pinos (9625 ft.); El Paso Co., Black Squirrel Creek, Pike's Peak Region; Lake Co., Leadville (10,000 ft.); San Juan Co., Silverton (10,000 ft.); Teller Co., Divide (10,000 ft.), Catamount Creek ((9400 ft.); Gunnison Co., Mt. Carbon (8500 ft.); Hinsdale Co., Carson (11,000 ft.); La Plata Co., Bob Creek (10,000 ft.); Chaffee Co., Buena Vista (7800 ft.).

16. SALIX BARCLAYI Anders. Oefv. Handl. Vet.-Akad. 15:125. 1858.—Shrub 1-4 m. high; twigs dark colored, purplish-brown to almost black, sometimes green on one side, never yellow or yellowish in our district, tomentose when young, glabrous very soon: leaves ovate-lanceolate, to oval or obovate, acute or cuspidate at the tip, cuneate to rounded at the base, or cordate on the vigorous shoots; 3-7 cm. long, 1.5-2.5 cm. wide; the margin crenate-serrulate, the glandular teeth inflexed; sparsely to densely pilose when first appearing, especially at the base, on midrib and veins of upper surface, soon disappearing, glabrous and glaucous beneath, reticulate; stipules large to small, lanceolate to ovate, acuminate, distinctly glandular-serrate: aments coetaneous; the staminate subsessile, but subtended by true leaves 1-3 cm. long, with glandular stipules; the pistillate on leafy peduncles 1-3 cm. long, the aments 2-6 cm. long, 1-1.5 cm. wide; scales almost black, lanceolate to ovate or obovate, mostly acute, villous with long hairs; capsules greenish, glabrous or thinly villous or pubescent at the tip, 5-7 mm. long; pedicels 0.4-1 mm. long; styles 1-1.7 mm. long; stigmas oblong to oval, mostly entire. Barclay's Willow.

Colorado specimens have less pubescence and shorter peduncles than those from Montana and British Columbia seen at the Arnold Arboretum, but in other respects agree with the type. Apparently the species is limited to the northern part of the state, growing abundant in Montana and further north. Schneider states that in some of these areas the forms approach *S. monticola.* Even so, the two are distinct. Leaves of the very short peduncles without glandular stipules; glabrous from the first appearance—*S. monticola;* leaves of the peduncles with glandular stipules; at first long-pilose. *S. Barclayi.*

C. A. C. Estes Park, (7500 ft.), Middle Park (8500 ft.).—W. U. Gilpin Co., Tolland (9600 ft.).

WOLFIANAE Schneider, Jour. Arnold Arboretum 3:70. 1922.—Shrub, small, erect, with divaricate branches: mature leaves firm, but thin, lanceolate, oblanceolate, rhomboid-oblanceolate and elliptic-lanceolate, usually entire, more or less silvery-sericeous: aments more or less coetaneous, short-pedunculate, small, ellipsoid, densely-flowered; stamens 2, filaments glabrous, distinct, anthers yellow, glands 2; capsules subsessile, glabrous; styles hardly 1 mm. long; the small stigmas bifid; gland 1, ventral; fruit conic-subrostrate from an ovoid-rhomboid base, 4-5.5 mm. long. This is a segregate from the Commutatae of Ball, emphasizing the points in which *S. Wolfii* and its variety differ from the other species of the Commutatae.

17. SALIX WOLFII Bebb, Bot. Wheeler Exp. 241. 1878.—Low shrub 6-10 dm. high; twigs yellow to orange when young, chestnut when older, lustrous:

leaves oblanceolate to elliptical, 2-4 cm. long, 8-13 cm. wide, acute at tip, rounded at base, entire, dull green and silky-villous on both sides when young, becoming glabrous or nearly so in age; petioles yellow, villous when young; stipules small or wanting: aments on short, leafy-bracted peduncles (6 mm. or less), the bracts often exceeding the aments; staminate aments 0.5-1.75 cm. long; the pistillate 1-2 cm. long, subglobose to oblong, densely-flowered; capsules glabrous, 3-4.5 m. long, greenish to reddish, drying brown; pedicels 0.5-1 mm. long; stigmas notched.

C. A. C. Grand Co., Cottonwood Pass (9000 ft.); Jackson Co., Rand (7500-8000 ft.); Larimer Co., Estes Park (5900 ft.); Routt Co., Gore Pass (9500 ft.).—C. R. B. Garfield Co., Trapper's Lake (9500 ft.); Gunnison Co., Mt. Carbon (9000 ft.); Lake Co., near Leadville (9800 ft.); Summitt Co., Greckenridge (9534 ft.); Arapahoe Nat. Forest (9000 ft.); Fitton Ranger Station (10,000 ft.).—N. H. Lake Co., Tennessee Pass (10,300 ft.); South Park; Whitehouse Mt. (12,000 ft.).

17a. var. IDAHOENSIS Ball, Bot. Gaz. 40:378. 1905.—Leaves larger, 3-6 cm. long, 1-1.8 cm. wide, oblanceolate: aments longer, 1-3.5 cm. long; peduncles in proportion: capsules about 5 mm. long greenish, thinly tomentose. Rare in Colorado, abundant in the region of Yellowstone Park.

C. R. B. Routt Co., Columbine (9000 ft.).

ARCTICAE Ball, in Coulter and Nelson, New Manual of Botany of the Central Rocky Mountains. 1909. — Low, erect or creeping alpine and subalpine shrubs, 1-10 or 15 dm. high; branches full of leaf scars: leaves small to medium, narrowly elliptic or oblanceolate, occasionally broader, entire, more or less tomentose; stipules small or none: aments appearing with the leaves, on short, leafy peduncles; scales brown, villous; capsules sessile or short-pedicelled, gray- or white-tomentose; styles 1-1.5 mm. long; stigmas medium, notched.

Erect or spreading shrubs 2-15 dm. high.
  Capsules and leaves gray-or yellowish tomentose, or leaves glabrate.
    Aments much longer than broad; leaves gray-tomentose, glabrate in late season, glaucous beneath ..... *S. pseudodapponum.*
    Aments subglobose to elliptical, leaves yellowish-tomentose beneath..... *S. brachycarpa*
  Capsules and lower leaf-surfaces densely white-tomentose..... *S. candida.*
Depressed, creeping alpine plants, less than 1 dm high.
  Leaves broadly elliptical to obovate, pale beneath, 2-4 cm. long..... *S. petrophila.*
  Leaves narrowly elliptical or obovate, 10-12 mm. long..... *S. cascadensis.*

18. S. PSEUDOLAPPONUM von Seem. Bot. Jahrb. 29. Beiblatt 65:28. 1900. —Low shrub 3-15 dm. high; twigs short and stout, pubescent at time of blossoming; branchlets reddish-brown, shining: leaves oblanceolate, elliptical, entire, apex acute, frequently cuspidate, base acute to rounded, young leaves more or less thinly grayish-villulose, at length glabrous or subglabrous above, glabrous and glaucous on the lower surface; stipules none or much reduced; petioles definitely longer than the buds: aments on tomentose, leafy peduncles 2-3 cm. long; scales at first green, then pinkish-red and finally brown, oblong, thinly villous; staminate aments 1-1.5 cm. long, 0.5 cm. wide; anthers ellipsoid: pistillate aments 2-4 cm. long, 1.5 cm. wide; capsules ovoid-rostrate,

grayish-villous, 5-7 mm. long; pedicels not over 1 mm., stout; styles and stigmas at first a rich purple, later yellowish or brownish. This species is usually found above timberline or just below, but authentic specimens have been collected in Estes Park at 7500 ft. Intermediate specimens between this and *S. brachycarpa* are not uncommon, but the typical specimens warrant the retention of the two species.

C. A. C. Larimer Co., Estes Park (7500 ft.), Trail Ridge (11,000-12,000 ft.). Poudre Lakes (10,797 ft.); Boulder Co., Brainerd Lake (10,000 ft.).—C. R. B. Costilla Co., S. Fork Culebra Creek (10,500 ft.), Independence Pass (11,095 ft.); La Plata Co., Lewis Mt. (11,500 ft.); Mineral Co., Wheeler National Monument (11,800 ft.); Gunnison Co., Mt. Carbon (10,000 ft.); El Paso-Teller Cos., Pike's Peak (9,000, 10,300, 11,500, 11,700, 12,000, 12,500 ft.); Routt Co., Ethel Peak (alpine).—N. H. Arapahoe Pass (11,905 ft.), Little Kate Basin, La Plata Mts., Mt. Hesperus, Bear Creek Divide, Pagosa Peak, Wolf Creek Pass (10,850 ft.).

Form b. Leaves oblong-oval to ovate, rounded at base, otherwise like the type.

C. A. C. Boulder Co., Brainerd Lake (10,000 ft.); Larimer Co., Trail Ridge (12,000 ft.), Specimen Mt. (11,500 ft.), Cameron Pass (10,285 ft.).—C. R. B. Berthoud Pass (11,315 ft.), Hoosier Pass (11,542 ft.), Loveland Pass (11,992 ft.), James Peak (11,000-12,000 ft.), Pike's Peak, Specimen Mt.; Clear Creer Co., Upper Chicago Lake (alpine); Garfield Co., above Trapper's Lake (10,300 ft.).—N. H. Marshall Pass (10,950 ft.), Alpine Tunnel (11,606 ft.), Carson Peak, Gunnison Watershed, (11,000 ft..), Long's Peak, Pagosa Peak (11,500 ft.), Telluride (12,000 ft.).

19. SALIX BRACHYCARPA Nutt. N. Am. Sylva 1:69. 1842.—A small alpine and subalpine shrub, occasionally found as low as 7500 ft.; branches stout and divaricate in our region, reddish-brown to yellowish or gray; twigs of the season grayish or yellowish, silky-villous: leaves elliptic-oblong, oblanceolate, rarely ovate- or elliptic-lanceolate or obovate-oblong, entire, apex obtusish or shortly acute, base broadly cuneate or obtuse, rarely rounded or abruptly subcordate, (on flowering branches small or very small, subspatulate or linear-lanceolate), from 2.5 by 0.6 cm. to 3 by 1 cm. (largest leaves 4.5 by 1.2 cm.), light green and somewhat tomentose above, pale yellowish-green and densely yellowish-tomentose to glabrate beneath, not glaucous; petioles 2-5 mm. long, not exceeding the mature buds and stipules: aments on very short leafy peduncles, the staminate in flower hardly more than 10 mm. by 4 mm.; the pistillate in fruit subglobose to oblong, 1.5 by 1 cm. to 2.5 by 1 cm.; capsules subsessile, ovate-lanceolate, obtuse, 4-5 mm. long, densely gray- or white-tomentose; styles 1-1.5 mm. long; stigmas medium. Again we have a characteristically alpine and subalpine species which occasionally reaches low altitudes. It is easily confused with *S. pseudolapponum*, but may be distinguished by the denser, shorter, more obtuse capsules and globose anthers.

C. A. C. Boulder Co., Brainerd Lake (10,000 ft.); Larimer Co., Trail Ridge (11,000-12,000 ft.), Long's Peak Inn (9000 ft.), Estes Park (7500 ft.)—C. R. B. Boulder Co., Arapahoe Nat'l Forest (9000 ft.), Cabin Creek (9250 to 9500 ft.), Red Rock Lake (10,100 ft.); El Paso Co., Manitou Reservoir, Pike's Peak (9000, 11,700, 12,200 ft.); Ruxton Park (9300, 8400 and 9500 ft.); Gunnison Co., Mt. Carbon (10,000 ft.); Jackson Co., Walden (8300 ft.); Lake Co., between Twin

Lakes and Leadville (9500 ft.); Larimer Co., East Beaver Creek (9450 and 9500 ft.); Mineral Co.,Wagonwheel Gap (8500 ft.); San Juan Co., Silver Lake (11,000 ft.); Summit Co., Breckenridge (9579 ft.).—N. H. Clear Creek Co., Berthoud Pass (11,315 ft.), Georgetown (8640 ft.); Empire (8600 ft.); Jackson Co., Cameron Pass (10,000 ft.).

19a. var. SANSONI Ball, Univ. Cal. Pub. Bot. 17:399-434. 1934.—This differs from the species chiefly in the smaller size of the plant and all its parts, especially in the shorter and relatively broader leaf blades and the subsessile, nearly globular aments.

C. R. B. Jackson Co., Higho.

20. SALIX CANDIDA Fluegge, Willd. Sp. Pl. 4:708. 1806.—A low, branching shrub, 3-10 dm. high, or occasionally higher; branches divaricate, light brown or yellowish; twigs densely white tomentose: leaves linear-oblong to narrowly oblanceolate, usually acute at both ends, margins revolute, entire or rarely crenulate and glandular, dark green, dull and thinly tomentose above, with deeply impressed veins, resembling those of sage leaves, densely white tomentose beneath, 3.5-8 cm. long, 3-15 mm. wide; petioles short (2-5 mm.), stipules lanceolate, not exceeding the petioles, tomentose, early deciduous: aments on short leafy, tomentose peduncles; staminate aments 1.5-2.5 cm. long, about 1 cm. wide, subsessile at time of blossoming, subtended by a few small, partly developed leaves, the peduncles lengthening somewhat as the season advances; scales light brown, pilose; filaments long and thread-like, glabrous; anthers red; pistillate aments 1.5-3.5 cm. long, 8-12 mm. wide; capsules lanceolate, white-woolly, short-pedicelled, 5-7 mm. long; styles reddish to orange, 1-1.5 mm. long; stigmas short, divaricate, notched.

None of the specimens examined is from Colorado, but a specimen so determined by Bebb and credited to Colorado in the Hall and Harbour collections is cited in Coulter's Manual of Rocky Mountain Botany and another specimen from the same collection and station is vouched for by Schneider as genuine *S. candida*. Since this species is known to occur in southern Wyoming it probably grows in a few spots in Northern Colorado.

21. SALIX PETROPHILA Ryd. Bull. N. Y. Bot. Garden 1:268. 1899 (*Salix arctica petraea* Anders. in part).—A creeping alpine plant, the very woody horizontal stems on or in the ground, sometimes 6 dm. long and 5-6 mm. wide, the branches erect, glabrous, brown or yellow, 3-8 cm. high: leaves elliptical to obovate, acute to obtuse and commonly apiculate at the tip, acute at the base, entire, deep green above, pale and subglaucous beneath, more or less thinly pilose when young, especially on midrib and veins below, soon glabrate, strongly veined, moderately reticulate, 1-4 cm. long, 1 cm. wide; petioles slender, yellow: aments coetaneous, many-flowered, on short leafy, pubescent peduncles; the staminate 1-2 cm. long, the pistillate 1.5-4 cm. long, 1 cm. wide; scales obovate to subarbicular, brown, thinly villous; capsules sessile, lanceolate, gray-villous to gray-tomentose, 4-6 mm. long; styles 0.5-1 mm. long; sometimes slightly cleft; stigmas divided, lobes linear. Rock-loving willow.

The most distinctly alpine willow of our district, yet, as in the case of other typically alpine forms, occasionally met with at altitudes as low as 10,500 ft. in the openings of the timber.

Schneider (Jour. Arnold Arbor. 1, 56) puts this species in a section which he calls Diplodictyae, containing *S. anglorum* and its varieties, *S. arctica* and its varieties, *S. ovalifolia* and varieties, *S. arctophila* and *S. hudsonensis*.

C. A. C. Boulder Co., Long Lake (10,500 ft.); Larimer Co., Trail Ridge (11,500-12,000 ft.), Flattop Mt. (12,200 ft.).— C. R. B. Garfield Co., Trapper's Peak (11,600 ft.); Grand Co., James Peak (11,800 ft.); Gunnison Co., Mt. Carbon (12,000 ft.); Larimer Co., Iceberg Lake (12,000 ft.); Mineral Co., (12,000 ft.); Routt Co., Ethel Peak; San Juan Co., Harteson Basin (12,000 ft.).—N. H. Chaffee Co., Mt. Harvard; Clear, Lake and Summit Cos., Gray's Peak (14,000 ft.); Gunnison Co., Marshall Pass (10,950 ft.); Larimer Co., North Park (timberline); Lake Co., Mt. Massive (11,300-12,200 ft.); Mineral Co., Pagosa Peak (12,000 ft.); Sagauche Co., Whitehouse Mt. (13,000 ft.); San Miguel Co., Telluride (12,000-13,000 ft.), Vallecito (11,500-12,500 ft.).

22. SALIX CASCADENSIS Cockerell, Muhlenbergia 3:9. 1907.—A creeping undershrub, the horizontal stem woody, short, slender in comparison with that of *S. petrophila*, the upright or ascending branches slender, yellowish, rising only a few centimeters (2-5) above the ground: leaves mostly oval, varying to oblanceolate, acute to obtuse, sometimes apiculate at tip, acute at base, entire, the youngest sparsely pilose beneath, soon glabrous, light green on both surfaces, 1-2 cm. long, 4-6 mm. wide: aments coetaneous, on very short, leafy, short-pilose peduncles; aments about 1 cm. long; scales black, obovate or oblanceolate, pilose; capsules grayish-villous, sessile, about 4 mm. long; style 0.5 mm. long. *S. tenera* Anders. in part. Schneider puts this species in Herbaceae Borrer. Rare in Colorado, common further north.

C. A. C. Trail Ridge, Larimer Co. (12,000 ft.).

PELLITAE Ryd. Col. Flora 93. 1906. (*Argenteae* as defined by Ball in Coulter and Nelson, Manual). Schneider (Jour. Arnold Arbor. 1:67) gives weighty reasons for discarding the section Argenteae and tentatively places *S. subcoerulea* in Dumortier's section Phylicifoliae. However, he suggests that Rydberg's "Pellitae" might well be used for the group with permanently hairy leaves if a more thorough study of the relationships of the different sections should prove that the American forms of the Phylicifoliae are more closely related to each other than to the species of the old world. Since our one species of this type is so very different from the species of the section Phylicifoliae found in the state, it seems best provisionally to adopt "Pellitae" for the section.

Shrubs 1-4 m. high; twigs rather long, brownish or yellowish, often lustrous and mostly pruinose; leaves narrowly oblong or oblanceolate, acute, entire or subentire, densely silvery-silky or silvery-tomentose beneath; sessile or very short-petioled, 1-6 cm. long, 1-2 (3) cm. wide; stamens 2; scales brown or black, hairy; capsules small, silvery-silky, sessile or short-pedicelled; styles elongate.

23. SALIX SUBCOERULEA Piper, Bull. Torr. Bot. Club 27:400. 1900.—Erect shrub 1-4 m. high; twigs glabrous, purplish-brown, usually covered with a dense bluish bloom: leaves lanceolate, oblanceolate, oblong-lanceolate or narrowy oval, tip acute to slightly rounded, margin entire or nearly so; dark green above, slightly pubescent to glabrous, with soft, silvery pubescence beneath; 4-6 cm. long, 1-2 cm. wide (on vigorous shoots sometimes to 12.5 cm. by 3.5 cm.); petioles 2-7 mm. long; stipules none or very small on vigorous shoots: aments precocious, usually sessile; scales brown to black, broadly ovate to obovate, pilose with hairs equal in length to the scale; staminate aments 1-3 cm. long, 1 cm. wide, anthers a striking red before shedding the pollen; pistillate 2-3 cm. (4-5 in fruit) long, 0.8-1 cm. wide; capsules ovate or ovate-lanceolate, subsessile or short-pedicelled, 3-5 mm. long, silvery-pubescent with short appressed hairs; pedicels never more than 1 mm. long; styles 1-1.5 mm. long, notched at apex, yellowish or brown; stigmas divided.

This includes *S. pachnophora* Ryd. (See Jour. Arnold Arbor. 1, 84.)

C. A. C. Boulder Co., Copeland Lake (8400 ft.); Jackson Co., North Park (8206 ft.); Jefferson Co., Berthoud Pass (11,315 ft.); Larimer County, Chamber's Lake (9500 ft.); Bartholff Park (8500 ft.), Cache la Poudre Cañon (8500-9000 ft.); San Juan Co., Pass south of Silverton (9500 ft.).—C. R. B. Clear Creek Co., Empire (8600 ft.); El Paso Co., Little Fountain Creek (9100 ft.); Gunnison Co., Anthracite Creek (8800 ft.), Mt. Carbon (9000 ft.); Lake Co., West of Tennessee Pass (10,000 ft.); Larimer Co., Glen Haven (7500 ft.), Cache la Poudre River (7800 ft.); Las Animas Co., Stonewall; Routt Co., Rabbit Ear Peak (9000 ft.); Sagauche Co., Marshall Pass (9000 ft.).—N. H. Pike Nat'l Forest; Uncompahgre Nat'l Forest; Routt Co., Hahn's Peak (alpine); Wagon Wheel Gap.

PHYLICIFOLIAE Dumortier in Bidjr. Natuurk. Wetensch. 58, 1825 (as limited to our region and excluding *S. subcoerulea*).—Much branched alpine or subalpine shrubs, 1-3 m. high; twigs short, divaricate, lustrous, brown: leaves small, elliptic-ovate, obovate or oblanceolate, usually entire, bright green and shining above, pale or subglaucous beneath, glabrous throughout or very thinly villous beneath with short silvery hairs: aments sessile, stoutish, densely compact: capsules sessile, gray-pubescent; styles elongated; stigmas thick.

Leaves elliptical to broadly obovate-elliptical ..... *S. planifolia monica.*
Leaves oblanceolate or lanceolate ..... *S. planifolia Nelsonii.*

24a. SALIX PLANIFOLIA var. MONICA (Bebb) Schn. Jour. Arnold Arbor. 1:78.—A shrub 0.5-3 m. high; twigs glabrous, bright chestnut to almost black, much branched: leaves elliptical, varying to broadly obovate-elliptical, abruptly acute (sometimes apiculate) at tip, acute to slightly rounded at base, margin usually entire, rarely somewhat glandular-crenulate or-serrulate, dark green, glabrous and shining, above, glaucous beneath, 2-3.5 cm. long, 0.8-2 cm. wide (on vigorous sprouts up to 6 cm. long, 3 cm. wide), at base of older branches often as small as 1 cm. long, 0.5 cm. wide; stipules wanting; petioles 2-5 mm. long: buds large (1 cm.) chestnut or darker: aments coetaneous; scales black, ovate, long pilose on both sides; the staminate 1-2.5 cm. long, 1 cm. wide, anthers red before dehiscence, turning dark purple in drying; the pistillate 2-3 cm. long, 1-1.3 cm. wide; capsules ovate-conic, sessile.

gray-pubescent, 4-6 mm. long; styles 1-1.5 mm. long; stigmas thick, mostly entire, rather long. *S. chlorophylla* Anders. in part; *S. monica* Bebb. Ball, the author of the Salix Section in Coulter and Nelson, now accepts the conclusions of Schneider concerning this species. For further details see Schneider's article (Jour. Arnold Arbor.).

A shrub of this species at Copeland Lake, Boulder Co. (8600 ft.) has peculiar buds, very broad and swollen at base. The bud scales are frequently thrown off during warm spells in winter, revealing a normal catkin with an adventitious bud, covered by its scale, on each side. The normal catkin, thus exposed to winter conditions, usually fails to develop its flowers and the adventitious buds function in early spring.

C. A. C. Boulder Co., Red Rock Lake (9800 ft.), Brainerd Lake (10,000 ft.), Long Lake (10,500 ft.); Grand Co., Grand Lake (8369 ft.); Jackson Co., North Park (8000-8600 ft.); Jefferson Co., Berthoud Pass (11,315 ft.); Larimer Co., Cameron Pass (10,255 ft.), Trail Ridge (11,000-12,000 ft.).—C. R. B. Boulder Co., Ward (9231 ft.); El Paso Co., Bobart Ranch, Pike's Peak (8250, 8400, 8900, 10,250 ft.); Gunnison Co., Slate River (8950 ft.), Lake Brennan (10,000 ft.); Lake Co., between Twin Lakes and Leadville (9500 ft.); El Paso Co., Pike's Peak (8250, 8400, 8900, 10,350 ft.); Gunnison Co., near Crested Butte (8950 ft.); Larimer Co., So. Fork of Cache la Poudre (8500 ft.); Routt Co., Rabbit Ear Peaks (9000 ft.), Park Range (10,095 ft.); Sagauche Co., Marshall Pass (10,950 ft.); Teller Co., Catamount Creek (9400 ft.); Cochetopa Nat. Forest (9000 ft.); Dutch Lake (9300 ft.); Independence Pass (12,095 ft.); Jenny Lake; Jones Peak (11,800 ft.).—N. H. Costilla Co., Mt. Blanca (13,000 ft.); Gunnison Co., Carsons (11,000 ft.); Hancock (11,000 ft.); Lake Co., Tennessee Pass (10,000-13,000 ft.); Park-Lake Cos., Buffalo Pass (11,500 ft.); Park-Summit Cos., Mt. N. E. of Boreas (11,500 ft.); Routt Co., Columbine (9000 ft.); Saguache Co., Marshall Pass (11,000 ft.); Little Kate Basin; Peak Valley (12,500 ft.); Virginia Pass (11,000 ft.).

24b. SALIX PLANIFOLIA var. NELSONII Ball, Bot. Gaz. 40:379. 1905. Now considered by Ball as a variety (personal letter).—A shrub 1-3 m. high; twigs glabrous, dark brown, young shoots occasionally have a faint bloom: leaves oblanceolate or rarely narrowly lanceolate, acute or short-acuminate at the apex, cuneate at base, 2-6 cm. long, 0.8-1.5 cm. wide, entire or the apical somewhat glandular-crenulate, rather strongly veined on both surfaces; stipules none: staminate aments sessile, naked, 1-2.5 cm. long, anthers red before dehiscence; the pistillate 2-5 cm. long, dense, naked or with a few small bracts at the base; scales black, ovate and acute to obovate and obtuse, long silky-pilose on both sides; capsules densely to sparsely pubescent, ovate-conic, 5 6 mm. long; styles 1 mm. long; stigmas as in var. *monica*.

This is the earliest willow to bloom at the middle altitudes. A succession of warm days may cause the bud-scales to fall off and expose the "pussies" in early January. In such cases the aments never mature on account of exposure to the succeeding cold weather, but if brought inside and placed in water sometimes produce flowers and even leaves. While most abundant at middle elevations it occurs in alpine situations associated with var. *monica*.

A shrub of this species in Estes Park (7500 ft.) shows the hermaphrodite condition, the staminate flowers always appearing at the tip of the ament.

C. A. C. Jackson Co., Rabbit Ear Pass (8600 ft.); Larimer Co., Estes Park (7540 ft.), Trail Ridge (11,700 ft.); Boulder Co., Copeland Lake (8700 ft.).—C. R. B. El Paso Co., Manitou Reservoir, Little Fountain Creek (9200 ft.); El Paso-Teller Cos., Pike's Peak (10,000 ft.); Lake Co., between Twin Lakes and Leadville (9500 ft.); Larimer Co., Beaver Creek; Ouray Co., Mt. Ouray; Routt Co., Routt Nat. For. (8700 ft.); Teller Co., Rosemont.—N. H. Mt. Lincoln; Peak Valley; Pike's Peak (10,000 ft.).

DISCOLORES Barratt, in Hook. Fl. Bor.-Am. 2:147. 1838.—Tall shrubs of wide distribution, 2-4 m. high; bark gray, twigs dark brown to black: leaves rather large, lanceolate-oblong to obovate, entire to crenulate or crenulate-dentate, more or less pubescent to tomentose, especially beneath, glabrate in age, dark green above, glaucous and strongly reticulate beneath: aments precocious, stout, dense, sessile or subsessile; scales broad, blackish, long-villous; capsules gray-pubescent, long-rostrate, 7-9 mm. long; pedicels 1-2.5 mm. long; styles short or none; stigmas divided.

25. SALIX SCOULERIANA Barratt, in Hook. Fl. Bor. Am. 2:149. 1839.—A shrub, commonly 3-4 m. high, but occasionally attaining tree size (9 m.); twigs rather slender, dark, glabrous to densely pubescent: leaves obovate to oblanceolate, rarely oval, apex abruptly acute or short-acuminate, base cuneiform or slightly rounded, margin serrulate to sub-entire, dark green and glabrate above, glaucous, strongly reticulate and sometimes densely tomentose beneath, 3-8 (4-10 cm.) long, 1.5-3.5 cm. wide; petioles 1-2 cm. long; stipules small, semi-cordate, acuminate, entire or dentate near base: staminate aments sessile, naked, 2-3 cm. long, 1-1.5 (2) cm. wide; pistillate short-peduncled, 3-7 cm. long, 1.5-2 cm. wide; scales black, obovate to ovate, acute to obtuse, long-pilose; capsules subconic, rostrate, tomentose, 7-9 mm. long; styles less than 0.5 mm. long, stigmas 1 mm. long, entire or divided; pedicels 1-2 mm. long.

Bisexual specimens from Rist Cañon (7600 ft.) display some aments wholly staminate, some wholly pistillate, while yet others contain both staminate and pistillate flowers in the same ament, the staminate always above.

This willow ranges from 7500 ft. to 11,000 ft. in altitude. While found in the usual moist situations, it also occurs in dryer situations than other willows of the district. One specimen on the west side of Rabbit Ear Pass is a real tree (8 m. high, stem 15 cm. thick).

C. A. C. Larimer Co., Rist Cañon (7600 ft.), Bear Lake, R. M. N. P. (9485 ft.), Dream Lake (10,000 ft.), High Drive (8800 ft.); Routt Co., west side of Rabbit Ear Pass (8000 ft.).—C. R. B. Boulder Co., Eldora (9000 ft.); El Paso-Teller Cos., Pike's Peak (8400, 8700, 9100, 9200, 9300, 9500, 10,200, 11,000 ft.); Gunnison Co., Mt. Carbon (9000 ft.), 10,000 ft., 11,000 ft.); Jefferson Co., Lookout Mt.; Larimer Co., Horseshoe Falls, R. M. N. P. (9200 ft.), Poudre Lakes (10,759 ft.), Bartholff Park (8200 ft.).—N. H. Jefferson Co., Golden (5693 ft.); County unknown, Little Kate Basin, La Plata Mts. (10,000 ft.).

ROSTRATAE Ball, in Coulter and Nelson, Manual p. 138. 1909 (*Fulvae* Barratt, Sal. Am. sect. VII. 1840. See Jour. Arnold Arb. 2:66).—Shrubs 2-5 m. high; twigs slender, divaricate, full of leaf scars, the younger very

leafy: leaves linear-oblanceolate to elliptic-oval, or oblong-lanceolate, mostly entire, more or less pubescent on both sides; stipules usually none: aments coetaneous; the staminate small, subsessile, with small, leafy bracts at the base; the pistillate on pubescent leafy peduncles, rather lax in fruit; scales linear-oblong, acute, thinly pilose, tawny, reddish at the tips: capsules long-pedicelled, conic-rostrate, 5-10 mm. long, pubescent; styles short or none; stigmas short, divided.

Twigs with glaucous bloom.....*S. Geyeriana.*
Twigs without bloom.
Leaves narrowly lanceolate, sharply serrate.....*S. petiolaris.*
Leaves elliptic to oblong-lanceolate, entire or sparingly serrate.....*S. Bebbiana.*

26. SALIX BEBBIANA Sarg. Gard. and For. 8:463. 1895.—A tall shrub, 2-6 m. high; twigs short, divaricate, brown or darker, glabrous or pubescent: leaves elliptic, oblong or oblong-lanceolate, acute, short-acuminate or obtuse, rounded at the base, sparingly serrate or entire, dull green and minutely downy above, pale and sparsely hairy beneath, especially on the raised midrib and veins, the mature leaves rigid, 2-5 cm. long, 1-2 cm. wide: aments sessile or subsessile, sometimes subtended by a few leaflike bracts; scales linear-lanceolate to narrowly oblong, pale yellowish-brown, with rose-colored tips, sparingly long-villous: staminate aments densely flowered, 1-1.5 cm. long, 0.5-0.7 cm. wide; the pistillate 2-4 (6) cm. long, 1-2 cm. wide, very lax in fruit; capsule tomentose, 6-8 mm. long, tapering from near the base into a long slender beak, style obsolete; stigmas entire or divided; pedicels slender, pubescent, 2-3 mm. long.

C. A. C. Larimer Co., Rist Cañon (6500 ft.), Big Thompson Cañon (7300 ft.).—C. R. B. El Paso Co., Black Forest, Manitou Reservoir; Larimer Co., Estes Park (7500 ft.); Teller Co., S. W. of Rosemont.—N. H. El Paso Co., Ruxton Dell (8000 ft.); Larimer Co., Horsetooth Gulch (5200 ft.).—W. U. Grand Co., Grand Lake; Mineral Co., Wagon Wheel Gap (8500 ft.); Cos. unknown, Chicken Creek; La Plata Mts.

26a. var. PERROSTRATA (Ryd.) Schn. Jour. Arnold Arb. 2:71.—This variety differs from the type by leaves obovate or oblanceolate, finely silky when young, later light green and glabrous above, pale and glabrous beneath, 2-4 cm. long, 1-1.5 cm. wide, entire or undulate (never serrate), thin, not becoming rigid; pistillate aments on leafy peduncles 1-3 cm. long.

C. A. C. El Paso Co., Pike's Peak; Larimer Co., Rist Cañon (6000 ft.), Big Thompson Cañon (7000 ft.), Estes Park (7500 ft.), Bartholff Park (8200 ft.).—C. R. B. Archuleta Co., Piedra (6450 ft.); Boulder Co., Boulder Cañon (6000 ft.), Ward (9231 ft.), Brainerd Lake (10,000 ft.); Costilla Co., San Acacia (7700 ft.); Douglas Co., 8 mi. SW of Sedalia; El Paso Co., Cheyenne Cañon, Monument (7000 ft.); El Paso-Teller Cos., Pike's Peak (6700, 6800, 7100, 8300, 8400, 8700, 8900, 9000, 9500, 10,000 ft.); Gunnison Co., Mt. Carbon; Larimer Co., Glen Haven (7000 ft.), Beaver Creek (9100 ft.); Las Animas Co., Stonewall; Pueblo Co., near Beulah; Summit Co., Blue River No. of Dillon; Teller Co., between Cripple Creek and Divide; Gilpin Co., Tolland (9600 ft.).—N. H. Conejos Co., Los Pinos (7000 ft.); Grand Co., Middle Park; Jefferson Co., Golden (6500-7500 ft.); Lake Co., Twin Lakes (9015 ft.); Montrose Co., Cimarron, Paradox Creek; Park Co., Cassells; Rio Blanco Co., Book Plateau; San Juan Co., Silverton (9300 ft.); County not known, Chicken

Creek (9000 ft.), South Park.—W. U. Boulder Co., near Boulder; El Paso Co., So. Cheyenne Cañon; Larimer Co., Gulch south of Rist Cañon; Montrose Co., Cimarron; Co. unknown, Ojo.

27. SALIX PETIOLARIS J. G. Smith, Trans. Linn. Soc. London 6:122. 1802. --A shrub 2-4 m. high: twigs slender, more commonly dark brown, but occasionally light yellowish-brown: leaves narrowly elliptical, lanceolate or oblanceolate, 4-8 cm. long, 1-2 cm. wide, acute to acuminate at both tip and base, margin sharply serrulate, mature leaves dark green and shining above, glaucous beneath, midrib and veins prominent, reticulate; petioles 4-6 mm. long; stipules minute, lanceolate: aments appearing with the leaves; scales yellow at base, almost black at apex, white-pilose, ovate to broadly triangular, mostly obtuse; staminate aments 1-1.5 cm. long, 0.6-0.8 cm. wide, filaments sparsely hairy at base; the pistillate on short leafy peduncles; capsules subconic, rostrate, silky-pubescent; stigmas sessile, divided; pedicels 1-2 mm. long.

S. petiolaris has not previously been reported from Colorado, but appears to be quite common, occurring in company with *S. Geyeriana*. It is easily confused with that species at the flowering stage, the young leaves not showing the serrulate margin and some specimens of *S. Geyeriana* not having the characteristic bloom on the twigs. Forms with leaves of the characteristic *petiolaris* type sometimes have bloom on the twigs. One hazards the statement that these are probably hybrids.

C. A. C. Larimer Co., Estes Park (7500-8500 ft.); Jackson Co., North Park (8050 ft.).—J. H. Crist. Teller Co., East of Divide; El Paso Co., Black Forest.

28. SALIX GEYERIANA Anders. Oefv. Vet.-Akad. Foerh. 15:122. 1858.—A shrub 3-4 m. high; twigs glabrous, very leafy, brown-purple to black, slender, usually (but not always) covered with a bluish bloom: leaves small, linear-oblanceolate or elliptical, acute or short-acuminate at tip, acute at base, margin entire, revolute, 2-4 (6) cm. long, 0.5-1.2 cm. wide, dark green above, somewhat glaucous beneath, silky-pilose when young, commonly glabrate when mature; stipules none; petioles slender, 3-5 mm. long: buds extremely small in summer (2-3 mm.), in late fall 5-7 mm., concolorous with stem: aments on pubescent leafy peduncles 0.5-1 cm. long, the leaves often exceeding the ament; scales linear-oblong to oblong, mostly acute, thinly pilose, tawny at base, the tips red; staminate aments 1 cm. long, 1-1.5 cm. wide; pistillate aments subglobose, 1-2 cm. long, 1-1.3 cm. wide; capsules rostrate, 5-7 mm. long, pubescent; pedicels stout, pubescent, 2-2.5 mm. long; styles short or wanting; stigmas short, divided.

From other species with bloom on the twigs it is easily distinguished by the smaller catkins and smaller leaves.

C. A. C. Boulder Co., So. St. Vrain Cañon; Grand Co., Middle Park (8200 ft.); Larimer Co., Estes Park (7500 ft.), Bear Lake (9485 ft.), Hidden Valley (8800 ft.), Cache la Poudre Cañon (8000 ft.), Pingree Park; Jackson Co., North Park-Walden (8050 ft.), Rand (8200 ft.), Murphy's (8200 ft.); Routt Co., Steamboat Springs (6762 ft.).—C. R. B. Slate River (8950 ft.); Gunnison Co., Mt. Carbon (9000 ft.); Lake Co., between Twin Lakes and Leadville (9500 ft.); Larimer Co., Pinkham Creek; Mineral Co., Caldwell Creek (8700 ft.); Ouray-Montrose Boundary, Mc-

Kenzie Creek; Routt Co., Columbine (9000 ft.); Saguache Co., Sargent's; San Miguel Co., Telluride (8500 ft.); Summit Co.—N. H. Grand Co., Sulphur Springs (7655 ft.); Gunnison Co., Crested Butte (9000 ft.).—W. U. Boulder Co., Ward (9231 ft.); Gilpin Co., Tolland (9500 ft.); Lake Co., Twin lakes (9400 ft.), Leadville (10,190 ft.); Co. unknown, Pactolus.

28a. var. ARGENTEA Schn. Jour. Arnold Arb. 2:74.—This variety differs from the type in the denser, more silvery pubescence of the young leaves and branches and in the greater permanence of this pubescence.

C. A. C. Larimer Co., Estes Park (7500 ft.), Bear Lake (9485 ft.).

RETICULATAE Fries, Sylloge Pl. Nov. Soc. Ratisb. 2:38. 1828. — Densely caespitose low or creeping alpine shrubs, 0.5-8 cm., not over 6 cm. high, with elliptical-oblong, obovate or suborbicular leaves, strongly reticulate and glaucous beneath; petioles slender, channeled; stipules none: aments on naked peduncles arising opposite the last leaf; capsules small, sessile, tomentose; styles none; stigmas short, divided.

29. SALIX NIVALIS Hook. Fl. Bor. Am. 2:152. 1839.—Scarcely 2 cm. high, from buried stems: leaves elliptic, oblong-obovate, or orbicular, acute, obtuse or retuse, 7-12 mm. long, 4-8 mm. wide, green and shining above, glaucous and strongly reticulate beneath, margins entire and revolute; petioles 2-7 mm. long, yellowish: aments globose or oblong, 3-6 flowered, 1 cm. long or less; scales oblong-obovate, obtuse, yellowish, nearly glabrous: capsules 2.5-3 mm. long, tomentose. Alpine summits, not common.

C. A. C. Trail Ridge (12,000 ft.).

29a. var. SAXIMONTANA (Rydb.) Schn. Bot. Gaz. 67:47. — Densely caespitose and much branched, 3-6 cm. high: leaves elliptic-oblong to suborbicular, obtuse or abruptly acute at the apex, acutish or rounded at the base, 1.5-2.5 cm. long, 1-1.5 cm. wide, light green above, glabrous throughout, glaucous and strongly reticulate beneath, margin entire and revolute; petioles 3-7 mm. long: aments 1-2 cm. long, several to many-flowered; scales broadly obovate, obtuse or rounded at the apex, cuneate at the base, yellowish, nearly glabrous; capsules 3-4 mm. long, densely white-tomentose.

C. A. C. Boulder Co., Lonk Lake (10,499 ft.); Gunnison Co., Ragged Mt.—C. R. B. Clear Creek Co., Upper Chicago Lake; Costilla Co., Mt. Baldy; El Paso Co., Pike's Peak, north side (11,300, 12,200, 12,000, 12,500 ft.); El Paso-Teller Cos., Pike's Peak (11,000, 11,700, 11,500, 12,400 12,450 ft.); Garfield Co., Trapper's Lake (10,500 ft.), Flattop Mt. (11,700 ft.), Wall Lake (11,000 ft.); Grand Co., James Peak (11,000-12,000 ft.); Ouray Co., Mt. Ouray; Park Co., Beaver Creek; Lake-Pitkin Cos., Independence Pass (12,095 ft.); Clear Creek Co., Loveland Pass (11,992 ft.); Montezuma Co. w. side of Mt. Elliott (11,300 and 11,600 ft.).—N. H. Clear Creek Co., Floral Mt. (12,000 ft.), Berthoud Pass (12,000 ft.); Clear Creek-Summit Cos., Gray's Peak and vicinity (11,000-13,000 ft.); Costilla Co., Mt. Blanca (14,000 ft.); Grand Co., Mt. Howard (10900 ft.); Gunnison-Chaffee Cos., Alpine Tunnel (11,606 ft.); Lake Co., Wallis Gulch (12,000 ft.); County not known, Mt. Garfield (13,000 ft.), Half Moon Creek (13,000 ft.), Clover Mt. (13,000 ft.), Vallecito (12,000 ft.).—W. U. Grand Co., Mt. Howard (10,775 ft.).

The type of the form is from Gray's Peak in Clear Creek Co. and is most

abundant in the Colorado Rockies. To explain its reduction to a "variety" rather than a species as described by Rydberg, note Schneider's statement (Bot. Gaz. 67:47)—"The type of *S. nivalis* Hooker was collected by Drummond near the summits of the peaks in the Rocky Mountains between Lat. 52-56. It is most frequent in the alpine region of the Rockies of Alberta and British Columbia, to a certain degree on the Tobacco Root Range, on Observation Mt. and Mt. Chauvet in southern Montana and on Electric Peak in Yellowstone Park and on Mt. Rainier (Piper). There are a few specimens from Colorado and SE. Utah which I can hardly distinguish from typical *nivalis* and which, in my opinion, form connecting links between it and *saximontana*. I take this last species, therefore, only for a variety of *S. nivalis*." Rydberg said (1889) "*S. nivalis* perhaps represents only the most depauperate form of *S. saximontana*" and in his Cat. Fl. Montana (19003, "the latter grades into *nivalis*"; while such an accurate observer as Piper (Contrib. U. S. Nat. Herb. 9:216. 1906) states "*saximontana* is probably not distinct from *nivalis*." A rather large series of specimens from Trail Ridge in the Rocky Mountain National Park supports this conclusion.

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DEPARTMENT OF BOTANY AND PATHOLOGY,
COLORADO COLLEGE OF AGRICULTURE AND MECHANIC ARTS,
FORT COLLINS, COLO.

Notes on North American Plants—II.

F. R. Fosberg

The second paper of this series contains range extensions and critical notes concerning the genera *Setaria, Carex, Chenopodium, Atriplex, Nitrophila, Mirabilis, Lewisia, Arenaria, Dianthus, Ceanothus, Elaeagnus, Echinocactus, Mosla,* and *Dicoria,* with new combinations in *Atriplex, Lewisia,* and *Echinocactus,* and a new variety in *Ceanothus.*

Abbreviations for herbaria are as follows:

(USNA)—Herbarium of the U. S. National Arboretum.
(US)—U. S. National Herbarium.
(UP)—University of Pennsylvania.
(USFS)—Herbarium of the U. S. Forest Service.
(UCLA)—University of California at Los Angeles.

SETARIA SPHACELATA (Schum.) L. & H.

This species was introduced at Chico in 1905 and 1906. That it had escaped and was occurring spontaneously in the central valley of California by 1928 is shown by a collection made in an irrigation ditch near Turlock, Stanislaus County *(Fosberg S699)* (UP, US, USNA), determined by J. R. Swallen. It is a native of Africa.

CAREX ROSSII Boott

The range of this species is given as "Bluff Lake, Cucamonga Peak; to Alaska" by Munz (Man. So. Calif. Bot. 74. 1935) with no mention of its occurrence on the islands off the Southern California coast. It is essentially a Rocky Mountain and Sierran species, comman eastward to Colorado and north to the Yukon. It may be recorded from Santa Cruz Island, Santa Barbara County, on the basis of *Fosberg S1919* (UP) collected in 1929 on hills between the Main Ranch and Eaton's (determined by F. J. Hermann). The material, though inadequate, resembles more this species than the northern coastal *C. brevicaulis* Mack.

CHENOPODIUM CARINATUM R. Br.

This weed is here recorded from Florida on the basis of a specimen collected in 1940, one mile north of Frink, Calhoun County, in dry pineland by Mary F. Baker (USNA).

Atriplex tenuissima Nelson var. **greenei** (Nelson), n. comb.

A. greenei A. Nelson, Bot. Gaz. **56**:65. 1913.

Hall and Clements (Carn. Inst. Wash. Pub. 326: 274, 1923) do not report *Atriplex tenuissima* from Colorado, nor do they make final disposition of *A. greenei.* Two collections from Colorado extend the range of *A. tenuis-*

sima to Colorado, and show some intergradation between Nelson's two species, as predicted by Hall and Clements (l. c.). The leaves of *Rollins 1917* are linear (or the upper smaller ones narrowly oblong) as in *A. greenei*, but as much as 2 mm. wide. The bracts are mostly of the general type shown in Hall and Clements' illustration (l. c. Fig. 34) of those taken from the type of *A. greenei*, up to 3 mm. long, but some are as short as 1.5 mm. and many are as broad in proportion as those of typical *A. tenuissima* shown in the same illustration. The tubercles or appendages are mainly about the middle, but on many bracts both above and below the middle, or one way or the other. *Nielson N-36* is more leafy, and the bracts, though mostly of the shape of *A. greenei*, are almost without tubercles or appendages. The plants of this collection have staminate flowers to below the middle of the plant, rather than in a few upper axils only. The preponderance of bracts of the form of *A. greenei*, in association with the narrower leaves on these collections seems to indicate that *A. greenei* should rank as a variety of the earlier *A. tenuissima*. More collections are greatly desired.

COLORADO: Mesa County, 15 mi. north of Fruita, alt. 5,000 ft., August 10, 1937, *Rollins 1917* (USFS, USNA); Moffat County, near Massadona, alt. 6,000 ft., July 10, 1936, *R. D. Nielson N-35* (USFS, USNA).

NITROPHILA OCCIDENTALIS (Nutt.) Wats.

This species, heretofore known from alkaline and saline places from Oregon to northern Baja California, and east to Nevada and Arizona, may be reported from Sonora, Mexico, where it was collected by *Thackeray* in 1925 at El Doctoro (USNA).

MIRABILIS EXALTATA (Standl.) Standl.

Known previously from Oklahoma, this species may be reported from 5 mi. e. of Seminole, Gaines County, Texas *(Hamby 1166)* (USNA), and from 8 mi. e. of Shamrock, Wheeler County, Texas *(Fosberg 14288)* (UP).

ARENARIA FRANKLINII Dougl., ex Hook. Fl. Bor. Am. 1:101. 1833.

A. franklinii Dougl. var. *minor* H. & A., Bot. Beechey Voy. 326. 1840.
A. hookeri Nutt., in T. & G. Fl. N. Am. **1**:178. 1838-40.
A. franklinii Dougl. var. *hookeri* Rydb., Bot. Surv. Neb. **3**:27. 1894.
A. pinetorum A. Nels. Bull. Torr. Cl. **26**:350. 1899.
A. franklinii Dougl. var. *Thompsonii* Peck, Torreya **32**:149. 1932.

This species may be reported from Nevada, Humboldt County, 110 miles north of Winnemucca, *Breene 337* (USNA); Churchill County, Sand Station Dunes, U. S. Highway 50, alt. 4350 ft. *Train 153* (US).

Despite its great variability, this is one of the most distinctive species of *Arenaria*. It may be recognized by its usually congested, usually flat-topped cymes of very large (for the genus) flowers, 5-12 mm. long, with petals a little longer or a little shorter than the lanceolate or lance-ovate very sharply acuminate sepals, and subtended by bracts similar to the sepals.

It is most variable in habit, from densely pulvinate with the individual branches much reduced and closely packed, as in *Graham 8324* (US) from the Uinta Basin, Utah, to elongate, lax and spreading (*A. franklinii* var. *thompsoni* Peck, Arlington, Gilliam County, Oregon, *Thompson 4769* (type, US)), or bushy and ascending (*A. pinetorum* Nels., Laramie Pk. *Nelson 1595* (isotype, US)). The inflorescence may be strongly exserted on sparsely leafy peduncles or nestled among the leaves. The inflorescences also vary in density (a very lax specimen collected by *M. E. Jones* in 1896 at Green River, Wyoming, (US)), and the flowers vary in length. These variations do not present convincing geographic ranges, though the Rocky Mountain plants are more often low and pulvinate (*A. hookeri* Nutt.). Transplant studies might well reveal some genetically distinct varieties. Perhaps the Uinta specimen cited above would prove to represent such. However that may be, the good series of specimens referred to the species listed above in the U. S. National Herbarium present the appearance one widespread variable species, rather than three. If the low Rocky Mountain form is to be recognized as a variety, it will have to be called *A. franklinii* var. *minor* H. & A.

This plant is frequently found in loose sand, especially in the West, though rocky and clay habitats are also commonly given by collectors. The range of the species, as here viewed, is from Washington and Oregon eastward through Idaho, northern Nevada, Montana, Utah, Wyoming and Nebraska.

ARENARIA VERNA L. var. PROPINQUA Fern.

In collections recently received from Nevada are two of this variety, from Charleston Peak Trail, on ridge to Peak, Charleston Mts., Clark County, alt. 10,000 ft., *Train 2290* (USNA); alt. 8,700 ft., *Train 2269a* (USNA), apparently the first to be reported from the State.

DIANTHUS ARMERIA L.

This weed was collected in 1938 in Blackfoot Valley, Missoula County, Montana, by *F. H. Rose (No. 499)* (USNA). It has long been abundant in the Eastern United States and more recently has appeared in the Puget Sound region.

LEWISIA PYGMAEA (Gray) Rob., Syn. Fl. **1**:268. 1897.

Talinum pygmaeum Gray, Am. Jour. Sci. II, **33**:407. 1862.
Calandrinia pygmaea Gray, Proc. Am. Acad. **8**:623. 1873. (not F. Muell.)
Calandrinia nevadensis Gray, Proc. Am. Acad. **8**:623. 1873.
Calandrinia grayi Britt., Bull. Torr. Cl. **17**:312.1890.
Claytonia grayana O. Ktze., Rev. Gen. 57. 1891.
Oreobroma pygmaea (Gray) Howell, Erythea **1**:33. 1893.
Oreobroma nevadense (Gray) Howell, Erythea **1**:33. 1893.
Lewisia nevadensis (Gray) Rob., Syn. Fl. **1**:268. 1897.
Oreobroma grayi Rydb., Mem. N. Y. Bot. Gard. **1**:137. 1900.

The difference between the two forms heretofore usually known as *Lewisia*

pygmaea and *L. nevadensis* have been given much more importance than they deserve. They may be summed up as follows: The bracts on the scape in *L. pygmaea* are supposedly above the middle, those in *L. nevadensis* at the middle; the sepals erose-denticulate in the former, entire and acute in the latter; petals slightly longer in *L. nevadensis*. The number of petals and of styles and stamens is quite variable.

Actually the relative length of peduncle and pedicel (position of bracts) varies even on the same plant. The sepals are usually obtuse and slightly acuminate in both forms, more acute in *L. nevadensis* but extremely variable in both.

The degree of denticulation varies so much that a sharp line cannot be drawn. On many apparently entire sepalled plants flowers can be found showing a suggestion of denticulation or irregularity.

Plants with denticulate sepals occur over a wider range—New Mexico, Colorado, Montana, Arizona, Nevada, Idaho, Washington, Oregon, and central-eastern California. Those with entire sepals occur in Nevada, Washington, Oregon, the Sierra Nevada, and the mountains of southern California. In Washington, at least, the two forms grow side by side. Because of the difference in geographic distribution, with the slight and varying morphological differences mentioned, I would call the two plants varieties of one species.

These observations are based on a large series of specimens in the U. S. National Herbarium and those in the U. S. National Arboretum plus numerous duplicates of those collected by the Nevada Indian Drug Plant Project.

The following combinations are necessary:

Lewisia pygmaea (Gray) Rob. var. **pygmaea** n. name.
The typical form based on *Talinum pygmaeum* Gray.

Lewisia pygmaea (Gray) Rob. var. **nevadensis** (Gray) n. comb.
Calandrina nevadensis Gray, Proc. Am. Acad. 8:623. 1873.

CEANOTHUS DENTATUS T. & G.

The range of this California Coast Range species is given in the manuals as from Santa Cruz County south to San Luis Obispo or (var. *impressus*) northern Santa Barbara County. Two specimens from Mendocino County have recently been sent in for identification. Both of these differ from plants from farther south in that the branchlets are more glandular, the branches not glaucous as is often the case in the southern plants, and the leaves less revolute and much less hairy beneath. They seem to represent a variety which is geographically and morphologically distinct.

Ceanothus dentatus T. & G. var. **dickeyi** n. var.

Ramuli valde glanduloso-pilosi, folia elliptica subplana subtus glauca sparse pilosa.

Branches green, branchlets terete, conspicuously glandular-pilose, the hairs spreading; leaves elliptic, mostly less than 1 cm. long, the margins slightly revolute, denticulate, the teeth very conspicuously viscid glandular, lower surface glaucous, with sparse subappressed pilosity on the midrib and veins but lacking any trace of the dense, often matted pubescence of the plants from farther south.

CALIFORNIA, Mendocina County: three mi. from Low Gap Rd. on Pine Ridge, Ukiah, August 7, 1939. *P. B. Dickey 747* (USNA) (type); 12 mi. n. of Willets, *Wieslander* in 1931 (USNA).

Echinocactus johnstonianus (Britt. & Rose) n. comb.

Ferocactus johnstonianus Britt. & Rose, Cactaceae **4**:287. 1923.

Examination of the type specimen, *Johnston 3394* (US), shows that this species is sufficiently distinct from *E. diguetii* Web. The genus *Ferocactus* Britt. & Rose seems best regarded (as by Berger, Kakt. 235, 1929) as a subgenus of Echinocactus. This species has evidently not previously been transferred.

ELAEAGNUS ANGUSTIFOLIA L.

The southern California specimen reported as *Shepherdia argentea* Nutt. by Munz, Man. So. Calif. Bot. 520. 1935, Jepson, Fl. Calif. II:557. 1936, and McMinn, Ill. Man. Calif. Shrubs 366. 1939, and as *Elaeagnus utilis* A. Nels. by Fosberg and Ewan, Bull. So. Calif. Acad. Sci. 34: 182. 1935, from Rancho Verde, Mohave River bed near Victorville, San Bernardino County, *Fosberg 8201* (USNA) upon further examination proves to be the introduced Eurasian "Russian olive," *Elaeagnus angustifolia* L.

This may be distinguished from *E. utilis* by its alternate, lanceolate acute leaves, much larger flowers, and larger, not very juicy fruits which are silvery rather than red. The branches are purple, long and flexible, with occasional thorns. It flowers when fully leafed out.

It has been previously known to be naturalized in Nevada and several middle-western localities.

MOSLA DIANTHERA (Buch. ex Roxb.) Max. Bull. Acad. Petersb. 20:456. 1875.

Lycopus dianthera Buch. ex Roxb., Fl. Ind. **1**:145. 1820.
Cunila buchanani Spreng. Syst. **1**:54. 1825.
Cunila nepalensis Don. Prodr. 107. 1825.
Melissa nepalensis Benth. in Wall. Pl. As. Rar. **1**:66. 1830.
Hedeoma nepalensis Benth., Lab. 366. 1832-36.
Mosla ocimoides Ham. (ms.), in Benth. Lab. 366. 1832-36.
Mosla lanceolata Maxim., Bull. Acad. Petersb. **2**:459. 1865.

KENTUCKY, McCreary County: moist wooded hillside by South Fork River near Alum Creek, Oct. 5, 1940, H. J. Rogers 1193 (UCLA); rich soil deposited in the mouth of Alum Creek at South Fork River, Sept. 23, 1939, *H. J. Rogers 306* (UCLA, USNA).

An herb with the aspect of *Perilla frutescens*, but more slender and with much smaller flowers and fruiting calyces.

The type of this species was grown in the Calcutta Botanical Garden, from material brought from Nepal. I cannot distinguish the several species that have been described of this relationship. Taken in a broad sense, the species is found throughout southern and eastern Asia and is quite variable. This seems to be the first time it has been found in America. How it happened to be introduced I do not know.

DICORIA CLARKAE Kennedy.

Munz records this (Man. So. Calif. Bot. 543. 1936) in California only from the Yuma Sand Hills in eastern Imperial County. It was collected in 1930 on sand dunes half way between Whitewater and Palm Springs, Riverside County *(Fosberg S2209)* (UP).

PLANT EXPLORATION AND INTRODUCTION,
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Cornus asperifolia and its Relatives

H. W. Rickett

The species which has long been familiar by the name *Cornus asperifolia* has ovate leaves scabrid above, villose and minutely papillose below; usually brown pith; white drupes about 6 mm. in diameter on red peduncles. In fruit it somewhat resembles *C. racemosa* Lam. It has occasionally been confused also with *C. stolonifera* Michx., though scarcely contiguous with it in range. The species so characterized is common in the southwestern central states, extending northward and eastward on old extensions of the prairies (*C. drummondi* in Fig. 1).

It is puzzling, therefore, to find *C. asperifolia* cited from the southeastern coastal plain in such works as Small's "Manual of the Southeastern Flora." I have seen no authentic specimens from any of the Atlantic states of the plant described above. This anomaly has occasioned an excursion into nomenclatural history, with rather surprising results.

C. asperifolia was described in Michaux' "Flora Boreali-Americana" (1:93. 1803) as follows: "*C. ramulis cymisque pubescentibus: foliis brevi-petiolatis, ovalibus, acuminatis; subtus asperiuscule subsemitomentosis; super minute rigidulaque pube asperis. . . . In sylvis umbrosis Carolinae inferioris.*" The significant points in this are the short petioles, and the pubescence and shape of the leaves; apparently Michaux did not see the fruit. The type locality is clearly on the eastern side of the Appalachians, and not within the range of "*C. asperifolia* Michx." as currently understood.

In 1896 Nash (Bull. Torrey Club 23:103) described *C. microcarpa* from Gadsden county, Florida. This species has since been collected at several places in western Florida and in Georgia. It fits the description quoted above well enough to leave no doubt that it is the true *C. asperifolia* Michx. and is responsible for the records of that species from the coastal states. It resembles the midwestern species in pubescence. But the leaves are not papillose, they tend to be smaller and oblong or elliptic rather than ovate, and have shorter petioles (usually 3–5 mm.). The styles and petals are shorter. The anthers and drupes are light blue, the latter about 4 mm. in diameter. Nash remarked (l. c.) "Dr. Chapman, in his 'Flora of the Southern United States,' p. 168, describes the fruit of the *C. asperifolia* of that work as 'pale blue.' In Coulter and Evan's [sic] monograph of the genus Cornus, the fruit of *C. asperifolia* is given as white. I do not remember having seen a white-fruited Cornus in the state. It is probable that all of the Florida material, hitherto referred to *C. asperifolia*, belongs here." It is curious that Nash did not realize that Chapman was right in his concept of Michaux' species and Coulter and Evans (Bot. Gaz. 15:35. 1890) wrong. Britton and Brown also in their "Illustrated Flora" (2:544. 1897) were close to a correct differentiation of the two species

when they wrote: "The southeastern plant *(C. asperifolia)* may be distinct from the western *(C. Drummondii)*." Their description, however, fits the "western" species only.

It is of some interest to trace the history of the misapplication of the name and to place the blame where it belongs. As noted above, Michaux apparently did not see mature fruit. Pursh must have been unfamiliar with the species, remarking (Fl. Am. Septent. 1:108. 1814): "Probably only a variety of the former species [*C. sericea*,=*C. amomum*]." Elliott (Bot. S. C. & Ga. 1:209. 1817) described the anthers as "purple," but did not mention the fruit. Of its habitat he wrote: "Grows in dry sandy soils, moderately fertile. Common near Beaufort [S. C.]." Torrey and Gray (Fl. N. Am. 1:651. 1840) mentioned the "very short petiole" and blue anthers, but added "fruit unknown." They also set up a var. *β* with *larger ovate leaves and longer petioles*, from Dr. Short in Kentucky. Here, evidently, the midwestern species

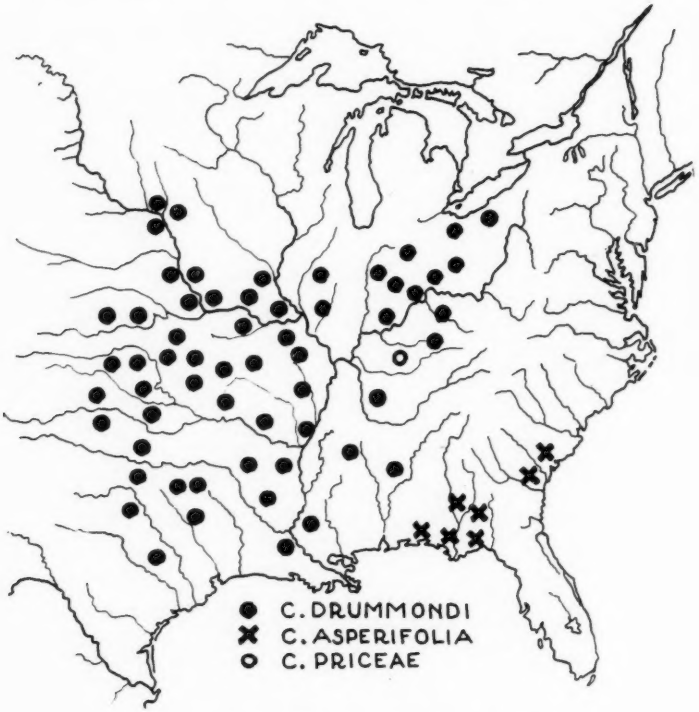

Fig. 1. Distribution of *Cornus asperifolia* and its relatives.

enters the picture, and is confused with the imperfectly known southeastern plant. In the second edition of Gray's Manual (1857, p. 161) the fruit and anthers are not mentioned, and the habitat and range become "Dry or sandy soil, Illinois and southward," to the exclusion of the type locality. The first description to include the fruit color was apparently that of Chapman, noted above (Fl. S. U. S. 167. 1860). As range he gave "Florida to South Carolina and westward," the last word doubtless reflecting Torrey and Gray's treatment. Wood's Class-book of 1861 (p. 392) reduced the species to *C. stricta β asperifolia* Feay (doubtless a manuscript proposal of Feay's), evidently on the basis of fruit- and anther-color; the range was given as "S. and W. states." Nevertheless in later editions of Gray's Manual the name *C. asperifolia* is definitely associated with the white-fruited species that grows from the "n. shore of L. Erie to Minn., Kan., and southw."

What name is available for the widespread and well known species hitherto known as *C. asperifolia,* since this name must be restored to the southeastern plant? The only other name ever applied to it seems to be *C. drummondi* Meyer (Einige Cornus-Arten, 20. 1845). As I have shown elsewhere (Rhodora 38:99. 1936), the plants seen by Meyer, though certainly to be included in *C. asperifolia* auct. non Michx., are definitely not typical of that species. My former suggestion that they were of hybrid origin has not been borne out by subsequent study, which indicates rather that they represent an extreme form perhaps associated with local conditions. Leaves with the woolly pubescence typical of the species and leaves with the appressed hairs characteristic of *C. drummondi* may be found on one bush, and transitions occur between them. I propose therefore to use Meyer's name, *C. drummondi,* for the species recently known as *C. asperifolia.* The advantage of this solution is the existence of *C. drummondi* in this sense in the older literature, and the avoidance of yet another name to cumber the synonymy of *Cornus.*

Cornus priceae Small (Torreya 1:54. 1901) differs from *C. drummondi* only in the size of its fruits (3 mm.), in which respect it resembles *C. asperifolia (C. microcarpa).* It is possible that the latter species may have offshoots around the Gulf Coast and up the rivers into the interior, which would permit hybridization with *C. drummondi.* This suggestion is supported by the existence of several specimens from Mississippi somewhat intermediate in leaf characters; but further critical collections will be necessary to confirm or disprove it.

THE NEW YORK BOTANICAL GARDEN,
NEW YORK, N. Y.

BOOK REVIEWS

AN INTRODUCTION TO THE STUDY OF ALGAE. By V. J. Chapman. University Press, Cambridge; The Macmillan Company, New York, 1941. 387 pp., 209 textfigs. $3.75.

Here is added another to the list of five or six textbooks on algae published in the English language during the past decade. According to the author there has been a pressing need of a short text for university students "containing the amount of information that could be conveyed in a series of lectures lasting over a period of 22-24 weeks at the rate of one lecture per week." Two-thirds of the book are devoted to classification and morphology; the last third to evolution, fossil algae, physiology, ecology, and distribution. Illustrations are copious, small, often uninformative, many of them original.

The morphological and systematic portion is not intended as a survey of all the genera. Only a certain restricted number is chosen for study; "some are described in considerable detail whilst others are mentioned merely to illustrate the course of development in either vegetative or reproductive organs." Those kinds of algae which the author feels are of great importance to the student are marked with asterisks; others, "e.g., *Gonium, Vaucheria,* have not been asterisked" for the reason that "they do not convey anything essentially new, or else because recent work has shown them to be wholly unsuitable types for elementary students."

The casual reader may notice at once that the types have not been selected because of their relative abundance on the surface of the earth, their economic importance, or their familiarity to phycological workers in general. The author, a marine ecologist who has produced a number of admirable papers in his field, would appear to be personally intimate with few of the microscopic species. The macroscopic marine genera receive much more comprehensive description than do the microscopic genera; in fact, almost half the discussion of morphology and classification is that of the Phaeophyceae and Rhodophyceae. The diatoms and dinoflagellates claim the attention on six pages, whereas the Phaeophyceae—a group perhaps comparable in number of species—are described in eighty-five pages. The Myxophyceae (termed Cyanophyceae), the bulk of Chlorophyceae, the Heterokontae (here called by the less familiar name Xanthophyceae), the diatoms, and the flagellates seem to serve only as entertaining illustrations of the course of evolution from microscopic ("lower") forms to more massive ("higher") forms.

The great idea which claims the author's enthusiasm in this part of the book and to which all else is subordinated is that of homologous evolution of the various groups of algae, as elaborated by Fritsch and others in recent years. This idea is here taken not as a theory, nor as a doctrine, but as the most important *fact* which a student will learn in a study of microscopic algae. The morphological information presented serves not particularly to support the idea as a theory, but as casual illustration of the well-known and universally accepted fact.

The author must be unusually naive to suppose that serious morphologists and taxonomists can accept this theory as other than just one explanation of the course of evolution based upon our present sketchy knowledge of these plants. Very little monographic work has been done in any of the groups; published systematic work of the past and present concerns itself in the main with purely local floras. The popular manuals of algae are almost without exception compilations of the work of their authors and of previous workers on such local floras. So little monographic work (in which the student is able to judge from the historical specimens—and not just from the published descriptions and illustrations—whether an author has drawn his figures or spoken sagaciously) has been done that our knowledge of what species exist, how they might logically group themselves into genera and families, and how they are distributed is a bewildering mass of

legend, fact, and misinformation. This is the "knowledge" which philosophers employ in constructing systems of phylogeny.

It is not conceivable to me that evolution in the Myxophyceae, a group as different in every morphological respect (except size) from the green algae as from the lilies, should necessarily proceed in any way comparable with that in the Chlorophyceae. Likewise, monographers of the diatoms, the flagellates, the Rhodophyceae, and the Phaeophyceae would find it hardly profitable to insist that evolution has proceeded in a similar fashion in their respective groups.

It would seem more proper, and even fairer to the callow student, for an elementary textbook on algae to describe the structure, function, and distribution of examples from all the genera commonly encountered on the earth—including those of all groups, not only those popularly considered the four major ones, but also the diatoms and flagellates. Controversial matters relating to phylogeny and evolution need be only briefly mentioned, if at all, for such subjects are to be discussed coherently only by dilettantes and by wise men.

It is interesting to note here that in Chapter IX (Reproduction et al.) the student is encouraged to additional reading and "then attempt to work out his own conclusions" concerning schemes of evolution and phylogeny of the algae.

The principal claim of this book to excellence and to recommendation to the teacher is the comparatively lengthy treatment of fossil algae, physiology, and ecology. Many of the fossil forms reported in the literature are mentioned or briefly described. The physiological and ecological discussions are reviews of selected papers published recently in various branches of these subjects. Little attention is given, however, to the older and often bulky literature. Ecology of marine and salt-marsh algae, especially of the British coasts, are dealt with in some detail. The chapter on freshwater ecology concerns itself mainly with recently proposed classifications of the associations and very little with the algae involved.

Seven pages are devoted to the soil algae. Six of these discuss the subterranean algae, a colorful and speculative subject upon which a few papers have been published. Why the ubiquitous surface flora, composed of hundreds of species confined to this type of habitat, should be described summarily on less than a full page is a question likely to arise in the mind of the critical reader.

The author's style is almost conversational and as such is often not effective in the expression of ideas. An example is on page 57, in explanation of vegetative division in the Oedogoniaceae:

"A thickened transverse ring, which develops near the upper end of the cell, first enlarges and then invaginates, the much thickened wall being pushed into the interior of the cell. Nuclear division now takes place near this end of the cell and a septum is laid down between the two daughter nuclei. Next, the outer parent cell wall breaks across at the ring and the newly formed membrane stretches rapidly now that the pressure is released—a matter of about 15 minutes—so that a new cell is interposed between the two old portions. The new transverse septum becomes displaced by differential growth of the two daughter cells so that it finally comes to rest just below the fractured parent wall, and it is also evident that the new longitudinal wall of the upper cell is almost entirely composed of the stretched membranous ring. The old walls form a cap at one end and a bottom sheath at the other, and as successive divisions always occur at the upper end of the same cells, a number of caps develop there and give the characteristic striated appearance to some of the cells."

On page 6 there is said of the blue-green algae: "This order used to be known as the Myxophyceae, but as this name was originally applied to a very heterogeneous group of organisms, it is now customary to employ the name Cyanophyceae." This statement is misleading for two reasons: it disregards the principle of priority of names so sacred to taxonomists; it omits to remark that the term Cyanophyceae has come into general use only among European botanists, who employ the name because it seems more appropriate

—most of the recent works by American and Asiatic botanists have used the older name Myxophyceae. Perhaps another example of careless writing is in the discussion of Merismopoedia on page 12, where the first two species mentioned make their début as *nomina nuda*, for I find no descriptions for them in the literature; it is possible that the statement made concerning them belongs on the preceding page under Microcystis.

A beginning student nurtured on this book alone should complete the university course in phycology without introduction to the publications of the excellent workers of the past. Kützing is mentioned once on page 194 in a several-page discussion of the origin and development of cryptostomata and conceptacles in the Fucaceae. The single reference to C. A. Agardh, Bornet, and Gomont is on page 298 in a paragraph on soil algae. Thuret, A. Braun, Wittrock, W. H. Harvey, Nordstedt, and Lemmermann are not listed in the index. The papers and books recommended to the student for additional reading are mainly of recent date. Monographs of special groups, even where they constitute the points of departure for nomenclature, receive no mention.—FRANCIS DROUET, Field Museum of Natural History.

A FLORA OF ARIZONA AND NEW MEXICO. By Ivar Tidestrom and Sister Teresita Kittell. The Catholic University of America Press, Washington, D. C. 1941. xxvi + 897 pp. $6.00.

Although this publication is signed by two authors, it is widely known (even prior to its appearance) as Tidestrom's Flora. The junior author thus perhaps loses some credit due her, but she gains much by exemption from criticism for the obvious shortcomings of the volume. Since these shortcomings are often to be found also in Tidestrom's "Flora of Utah and Nevada" (Contr. U. S. Nat. Herb. 25. 1925), it is clear that the junior author contributed very little if any to the confusion in the new Flora.

A first glance at the book is rather discouraging. The format is unsatisfactory, being an offset of a rather poorly typed original. Although the family and generic headings stand out distinctly, several adjacent species become so confused with one another that real difficulty is experienced in locating any given species on a page. Synonymous names are set off by italics, but accepted names are in no wise distinguished, and the spacing does nothing to aid the eye. The species numbers are of very little help since they do not stand out and are easily confused with numerals in the descriptions when these appear at the left-hand margin.

The specific descriptions are conspicuous by their brevity and frequent absence. In *Quercus*, where any aid to identification is doubly welcome, the diagnoses consist mostly of nonessential characters, and most of the distinguishing characters are omitted. In many cases (see, for instance, *Astragalus Thurberi* and *A. recurvus* discussed below) the diagnoses contradict the characters mentioned in the keys.

The keys are nicely simplified, but in those keys most closely analyzed by this reviewer, it is evident that the characters are not conclusive and often that they are not true. For instance, *Quercus grisea* and *Q. reticulata* have acorn cups more frequently hemispheric than saucer-shaped. In the key to *Astragalus* leaflet measurements from "5 to 10 mm." opposed to "10 to 20 mm." as the sole distinction are hardly reassuring. Scarcely better is the distinction between *A. Thurberi* and *A. recurvus* in the key as "Leaflets linear-oblong to oblong" opposed to "Leaflets linear-oblong to obovate." Both these species are then described as having leaflets "linear-oblong or broader." In *Sophora* one must decide if the plant is a "shrub 1 to 2 meters high" or a "perennial." These examples could be multiplied endlessly.

One of the most conspicuous features of the treatment is a lack of uniformity in style and a frequent breach of the generally accepted rules. Undesignated trinomials appear more often than those designated as to rank by "var." or "v." Yet all three forms are used to present names first designated as "varieties" by their original authors. This same lack of regard for the rank of a name appears in the treatment of subgeneric groups. The segregate genera of *Astragalus* are all presented as subgenera. No authorities or synonyms are cited although some of these subgenera have previously been pub-

lished and some are here published for the first time.

No indication is given whether a name is new or not. In the case of new combinations the binomial (or trinomial) is merely followed by the authorities alone. The designation "comb. nov." is not employed except by the junior author.

Thus this volume presents a horrible problem to the bibliographer who must ferret out all the unintentional new combinations and *status novi* which appear unannounced throughout.

Some new names are proposed without any justification, stated or otherwise. *Astragalus feensis* Jones becomes *A. Santae-Fidei* Tidestrom, no reason offered. *Cymopterus Crayanus* Tidestrom is proposed for *Thaspium montanum* Gray, not *C. montanus* Torr. & Gray, although *Pseudocymopterus Tidestromii* Coult. & Rose, *P. purpureus* Rydb., *P. tenuifolius* Rydb., *P. filicinus* Woot. & Standl., and *P. multifidus* Rydb. were all available for this species complex. *Dalea Thomsonae* (Vail) Tidestrom is proposed as a new combination although this combination had already been made by L. O. Williams (Ann. Mo. Bot. Gard 23: 451. 1936), while *Dalea Grayi* (Vail) L. O. Williams (l.c., p. 450) is recognized and the place of publication erroneously cited as p. 45.

Although it has been generally understood that the Flora was intended to follow the International Code of Botanical Nomenclature, the departures from this code are so frequent as to cast some doubt upon the existence of such an intention. For instance, although the conserved generic names *Corydalis* and *Cracca* are employed, the rejected or synonymous names *Odostemon, Peramium, Ophrys, Microstylis* and *Serapias* are used. It would appear that the *Orchidaceae* had not been revised since the first writing of the manuscript over a decade ago when the American Code was being followed. Other evidences of a confusion of the principles of the International and American Codes are obvious here and there.

Probably the most serious fault of the Flora is the great number of omissions. The failure to include the family Oxalidaceae may be considered as merely a rather large oversight. Much more serious than this, however, is the omission of much of the recent literature. For instance, *Ailanthus altissima* (Mill.) Swingle which replaces *A. glandulosa* Desf. is not used although the name has been employed in various conspicuous publications and appears in both Index Kewensis and the Gray Herbarium Card Index. *Quercus hypoleucoides* A. Camus replaced *Q. hypoleuca* Engelm. (not Miquel) in 1932 (but not in this Flora). Standley published this revision of *Choisya* containing the original description of *C. arizonica* in 1914, but that name does not appear in the Flora. Certain ones of the outstanding recent monographs are mentioned. For instance, Kearney's treatment of *Sphaeralcea* was obviously consulted and largely copied. There is very little evidence, however that Munz' work on the *Onagraceae*, Epling's on the *Labiatae*, Hitchcock's monograph of *Lycium*, Steyermark's of *Menodora*, Barkley's of *Rhus*, or numerous others of the past decade have been consulted at all. It is clearly evident that no recent general use was made of Index Kewensis or the Gray Index.

It would be very gratifying to give now an equal list of favorable criticisms, but unfortunately little of that nature has come to light. It might be mentioned that in general the treatments of *Juncaceae, Cyperaceae, Gramineae*, and *Pteridophyta* are immeasurably superior to the balance of the Flora.

One wonders why a reputable institution would permit the use of its facilities in publishing such a work without imposing at least some effective editorial review.

The price, considering the context and reproduction, is excessively high.—CORNELIUS H. MULLER, Bureau of Plant Industry, U. S. Dept. of Agriculture.

FIELD BOOK OF SNAKES OF THE UNITED STATES AND CANADA. By Karl P. Schmidt and D. Dwight Davis. G. P. Putnam's Sons, Publ., New York, 1941. 365 pp., illustrated. $3.50.

The appearance of a volume on snakes in the series of Putnam Nature Field Books will be heartily welcomed by both professional and amateur naturalists. The general

excellence of the series, plus the outstanding caliber of the men who have written them, has given the Putnam handbooks an enviable reputation.

The "Field Book of Snakes" begins with chapters on the place of snakes in nature and the folklore of snakes, followed by an interesting and concise essay on the history of snake study in the United States. Much space is devoted to such topics as definition, classification, means of identification, habits and behavior, collecting and preservation of specimens, etc.

It is in the section entitled "Systematic Account of the Snakes of the United States and Canada," however, that the professional herpetologist or advanced amateur will center his interest. This section forms the bulk of the book and in it the authors have succeeded in assembling a wealth of information which, while in condensed and often streamlined form, summarizes the highlights of almost everything known about the snakes that occur north of the Mexican boundary. Each group or genus is first treated as a unit and is then followed by a brief description of each of the various forms which comprise it. Information, when known, is given on average and maximum size, food, habitat, habits, reproduction, etc. Facility in identification is rendered by a main key to genera, and numerous smaller keys, concerned with individual genera.

Each section is accompanied by one or more references to technical papers in which detailed information may be found. These, in conjunction with a lengthy bibliography arranged by states, form an excellent guide to the literature on North American snakes. The authors have been especially generous in crediting information to their professional colleagues and predecessors; the text is literally studded with the names of herpetologists.

Ranges are stated for each form and several range maps, based in large measure upon important recent monographs, are included. It is regrettable that more such maps were not prepared and made part of this book.

A total of 222 species and subspecies is included. Nomenclature, in the main, follows the 1939 edition of the "Check List of North American Amphibians and Reptiles" by Stejneger and Barbour; where the opinions of Schmidt and Davis differ from the check list, there are appropriate footnotes of explanation. A number of forms described since 1939 are included, and the scrupulousness with which the authors have brought their manuscript up to date is attested by the fact that they include species which were named just a few months prior to their own publication date.

The more than one hundred drawings (some of them in color) by Albert A. Enzenbacher are excellent. The effectiveness of the black and white ones is marred, rather seriously in some cases, by the paper used in the book, which is not nearly so well suited for the reproduction of line cuts as the paper used in other recent Putnam field books. The 82 photographs, printed on coated paper, are good. Most are by the junior author, but some of them fail to measure up to the high standard set for reptile photographs in recent years by such men as Gloyd, Klauber and Mooney.

Although typographical errors in the text are rather numerous, technical errors and awkward grammatical constructions are much less frequent. The captions accompanying the photographs are confusing since there is no apparent consistency in the use of binomials and trinomials; a large number of forms treated trinomially in the text are given binomial designations in the captions. The usefulness of the plates might have been increased considerably by indicating text references under each of the photographs. The reviewer, however, has twice been guilty of similar omissions in his own publications.

One thing that may strike the reader quite forcibly, however, and especially if he be an amateur, is the urgent need for standardization of common names. No less than five popular snake books have been published in the last five years, including this one, and even a cursory perusal of them indicates the woeful inconsistency in common names. Amateur interest in herpetology is now so great and widespread that professionals no longer can ignore the necessity for standardization. Certainly, the American Society of Ichthyologists and Herpetologists should take active steps at once to study this situation and act upon it. The American Ornithologists' Union long since designated official vernacular bird names and it can point to the fact that over a period of years the common names have remained more stable than the scientific ones.

The merits of the "Field Book of Snakes of the United States and Canada" are such that in all probability it may soon occupy the same preeminent position that was held for many years by Ditmar's "Reptile Book," a volume that once served as a "bible" to many more professional herpetologists than care to admit it. Despite its minor errors and imperfections, Schmidt and Davis's book is not only an outstanding credit to its authors but also to their profession.—ROGER CONANT, Zoological Society of Philadelphia.

SYSTEMATIC CATALOGUE OF THE FISHES OF TORTUGAS, FLORIDA. By William H. Longley. Edited and completed by Samuel F. Hildebrand. Carnegie Institution of Washington Publications 535. 1941. xiii + 331 pp., 33 plates, 70 figures. $2.50 paper, $3.50 cloth.

This publication—the best of its kind for the area involved—is outstanding in that the majority of the observations which were made over a period of twenty-five years by the late Dr. W. H. Longley, were accomplished beneath the surface of the water with the aid of a diver's outfit and water-tight photographic equipment. The untimely death of Dr. Longley prevented the catalogue from being as complete as it otherwise might have been. Some of Dr. Longley's notes were known only to himself and in most cases pertinent information was forthcoming only after painstaking indexing of heterogeneous notes and data on the part of Dr. Hildebrand who prepared the material for publication. In a great many instances Dr. Hildebrand provided information of his own and here and there supplied keys to genera and species. All but thirteen of the seventy figures are excellent photographs of fishes in their natural habitat. The various families and most of the genera are arranged in an evolutionary sequence after the fashion of Jordan, Evermann, and Clark in their "check list."

While this work will be of interest and use to the ichthyologist and biologists in general, the photographs are of such quality that they can be appreciated by anyone. —J. D. MIZELLE.

BUTTERFLIES. By Ralph W. Macy and Harold H. Shepard. University of Minnesota Press, Minneapolis. 1941. vii+247 pp. Illustrated. $3.50.

Those actively or potentially interested in butterflies will welcome the handbook recently prepared by Professors Macy and Shepard. In this book of nearly 250 pages, the authors treat of all the butterfly species which normally occur in northeastern North America.

"Butterflies—A Handbook of the Butterflies of the United States, complete for the Region North of the Potomac and Ohio Rivers, and East of the Dakotas" includes not only a discussion of each of the 162 species inhabiting the region specified but also valuable remarks on folklore connected with these insects, butterfly odors and sense organs, hibernation and migration, life zones or zoogeography and methods of collecting and preserving specimens. Simplified keys are given which should enable even the beginning student to name correctly normal specimens of any of the species. Four colored plates add a nice touch to the volume and numerous black and white illustrations serve to clarify the text. The letterpress and makeup of the book is quite pleasing; and all in all it is a credit to both authors and publishers.—EDWARD A. CHAPIN, U. S. National Museum.

MAN AND THE VERTEBRATES. By Alfred Sherwood Romer. University of Chicago Press, 1941. x + 405 pp., many figs. and plates. $3.50.

In this revised edition, Dr. Romer's well-known text at last appears in modern dress. It matches Buchsbaum's *Animals Without Backbones* in style and format, with equally attractive rotogravure plates and more attractive text figures. Together, these volumes form a modern survey of systematic zoology for the college, public or private library, as well as for instruction.

In revising his book, Dr. Romer has retained emphasis on the historical development of vertebrate groups, thus uniting material which too often is divided between paleontology and zoology. Much of the text has been rewritten; the treatment of higher fishes and birds has been brought up to date, and a chapter on the frog has been added as a guide to laboratory study. Chapters on fossil man and human races are virtually new. The former presents recent discoveries concerning *Pithecanthropus* and *Sinanthropus*, with illustrations which are even better than those to be found in the sources.

The treatment of modern races, while not novel, departs radically from that of most time-honored textbooks. Dr. Romer suggests that Cro-Magnon characters survive among the peoples of Ireland, Atlantic coastal Scandinavia and northern Germany, but does not include the Basques. The purest Nordics of Scandinavia and the eastern Baltic states appear to be "bleached" Mediterraneans; Nordics are relatively rare in Germany, where this race has been venerated. Though much Nazi anthropology is nonsense, Der Fuehrer seems to have been on solid ground when he shifted his claims from Nordics to Aryans. Contrary to popular opinion, Aryan is not a racial term, but is one which depends upon speech or culture. It therefore, as Dr. Romer curtly comments, is not part of biology.—CARROLL LANE FENTON.

CYTOLOGY, GENETICS, AND EVOLUTION. By M. Demerec *et al.* University of Pennsylvania Bicentennial Conference. University of Pennsylvania Press, Philadelphia. 1941. 168 pp. $2.00.

Blakeslee justly names the zoological laboratories of the University of Pennsylvania "an outstanding center for the study of chromosomes," and the University, celebrating in part its bicentennial by the publication of this group of lectures, has successfully commemorated its interest in the nucleus, its contents and its activities. The small volume deserves a place in the library of everyone interested in genetics, cytology, cytogenetics and evolution.

The twelve papers contained in the book are grouped in threes under four appropriate subtitles. The first of these four groups, entitled "Chromosomes and Heredity" includes: *The Nature of the Gene*, by M. Demerec which is a discussion of effects that various kinds of chromosomal rearrangements within the X-chromosome of *Drosophila* have on some genes or their activities, and the possible chemical constitution of the salivary gland chromosome; *Chromosome Structure*, by Charles W. Metz, which is a clear presentation of some of the views held regarding the nature of the chromonema, and the inability of anyone to draw any definite conclusions concerning its fundamental nature; and *The Sex Chromosomes: Heteropycnosis and Its Bearing on Some General Questions of Chromosome Behavior*, in which Franz Schrader describes the value of using the heteropycnotic sex chromosomes in some of the Heteroptera in the study of chromosomal movements.

"Cytogenetics and Evolution" — the second part of the book — is opened by Albert F. Blakeslee with *Chromosomal Interchanges*. This is a description of the discovery of segmental interchange in *Datura*, and, *inter alia*, the analyses of the chromosomes of the various races and species. In *Chromosomal Differences Between Races and Species of Drosophila* Th. Dobzhansky reviews the evidence bearing on the evolution (as opposed to catastrophic changes) of the chromosomal apparatus in *Drosophila*, stressing particularly the fact that chromosomal differences between species are often found within a single species. Clarence E. McClung closes this section with *Evolution of the Germplasm*. This interesting discussion is a generalized one of the manner in which "that substance, or organization which distinguishes a chromosome complex" has probably evolved, and of the courses which future researches must follow in order to yield an understanding of "racial and individual development."

The third section, called "Cytology and Genetics of Protozoa," contains *Hereditary Status of the Rhizopods* by Herbert S. Jennings, *Nuclear Behavior and Reproduction in Ciliated Protozoa* by William F. Diller, and *Inheritance in Ciliated Protozoa* by T. M.

Sonneborn. In the first of these Jennings reviews again the results of his studies and those of Jollos with the Rhizopods. Selection within a single clone of these vegetatively reproducing forms has resulted in the establishment of biotypes differing in inherited characteristics — but these biotypes are not absolutely permanent. The non-Mendelian nature of this inheritance and the effectiveness of the environment on these forms in producing inherited characters should be of profound interest to all geneticists. Closely related to this in Sonneborn's description of the genetical situation in the ciliates, in which he discusses many instances which, in his words, "are extremely difficult to interpret along orthodox genic lines." Among other things, he includes the inheritance of mating types I and II in *Paramecium aurelia*, Dauer modificationen, and hereditary differences within a clone. Diller describes representative kinds of nuclear behavior found in various of the ciliates, and presents an interesting series of the types of phenomena suggesting "the evolution of sexuality" in these forms.

The fourth section is called "Physiology of the Nucleus." Leon Churney's *The Physico-chemical Properties of the Nucleus* discusses the colloidal properties of the nucleus, viscosity of the nucleoplasm, the osmotic reactions of the nucleus, permeability of the nuclear membrane to water, and the amphoteric nature of the nuclear components. William R. Duryee in *The Chromosomes of the Amphibian Nucleus* describes his micromanipulations of amphibian chromosomes, with particular reference to the lateral loops, the reactions of the chromosomes and the lateral loops to various chemical agents, and "nucleolar production." The production of lateral loops and the production of nucleodi are offered by him as two ways in which the nucleus functions in the cell. *Radiation and the Cell Nucleus*, by Paul S. Henshaw closes the book. This paper discusses the elements of the nature of matter and radiation, and treats the action of radiation on living matter and the response of that matter to the radiation, postulating three kinds of responses based on his experiments with sea urchin gametes.—E. LAWRENCE POWERS, JR.

ANIMAL BIOLOGY. By Michael F. Guyer. Harper and Brothers, New York and London, 1941. xix + 723 pp., numerous illustrations. $3.75.

This, the third edition of Animal Biology is admittedly a textbook designed for the principle type of course in elementary zoology. It is conveniently divided into six parts which are provided with excellent illustrations and are remarkably free from errors. The first part, The World of Life, deals with divisions of biology and zoology, characteristics of life, protoplasmic organization, various advantageous morphological changes throughout the animal kingdom, certain basic phenomena regarding plants and an ecological treatise in which modern terminology and concepts of the subject are used. Part two, Representative Animals, which is a detailed account of the leopard frog *(Rana pipiens)*, *Euglena*, *Paramecium*, *Hydra*, *Obelia*, planaria, and the earthworm *(Lumbricus terrestris)*, greatly facilitates laboratory instruction. Part three, Organ Systems and their Functions, is written chiefly from the vertebrate standpoint and includes a chapter devoted to human behavior. Part four, The Origin of Organisms, is a treatment of closely related phenomena dealing with abiogenesis, mitosis, various embryological processes, and genetics. Part five, Origin of the Kinds of Animals: Evolution, is an extensive treatment of evidences for organic change, for the beginner, and comprises more than 100 pages of material. Part six, Synoptic Survey of the Animal Kingdom, is a brief but good account of fourteen animal phyla. An accompanying laboratory manual includes material for work on representatives of the various phyla with 120 pages of the 269 devoted to *Rana pipiens*.—J. D. MIZELLE.

AMOS EATON, SCIENTIST AND EDUCATOR. By Ethel M. McAllister. University of Pennsylvania Press, Philadelphia, 1941. xiii + 587 pp. 8 plates. $5.00.

Those who have read the biographies of James Hall, John Torrey and other American scientists of the early nineteenth century know the name of Amos Eaton. Yet they have glimpsed him only briefly as lawyer, land agent, traveling lecturer,

geologist, botanist, author of textbooks, teacher and writer on pedagogy. Too often, the inference has been drawn that he also was an unstable eccentric, if not a charlatan.

That error is well corrected by this detailed, abundantly documented book. Beginning with a brief history of the Eatons, it traces the early years and training of Amos and chronicles his family life, which was one of repeated tragedy. After an education more thorough than was characteristic of his time, Eaton set up in 1802 as a land agent and lawyer. He achieved some success in both fields, but it was destroyed by imprisonment for forgery. Records leave no doubt that he was victim of a plot, for the judge was corrupt, the evidence false, and the crime for which he was sentenced was one supposedly committed long after his indictment. All to make profit for Eaton's accuser, who had sold him land!

Imprisonment seemed to be disaster; it actually gave Eaton his chance to become a scientist and teacher. As prison clerk he earned the respect of DeWitt Clinton, Samuel Mitchill and William Torrey, whose son John became his closest friend. He wrote a book on plants and another on surveying, gave John Torrey his first lessons in botany, and was pardoned in 1815, with the active aid of Clinton.

A free man again, Eaton spent a year at Yale, lectured at Williams College, and began the period of itinerant lecturing which caused him to describe himself as a "successful scientific pedlar." He taught men and women in town halls, took his students on field trips, studied plants and rocks, and wrote his own textbooks. For its day, his *Manual of Botany* was a best-seller, his *Geological Textbook* was a pioneer, and his reports on the geological and agricultural resources of Rensselaer County and the region along the Erie Canal were sound contributions to science.

Eaton enjoyed his "peddling," but he also wanted a permanent home and a chance to develop his theories of science teaching. The opportunity for both came in 1824, when Stephen Van Rensselaer agreed to support an institution for the "application of science to the common purposes of life." Eaton became agent, senior professor, and most of the faculty. In spite of scanty equipment and limited funds, he made the Rensselaer school famous as one in which young men learned science by practicing it, and were trained as teachers by teaching under a critic. The method produced leaders of research, and it also gave useful training to many mechanics, schoolmasters, engineers and farmers.

The tale of Eaton's life is stirring; Miss McAllister tells it without sentimentality and with adherence to the records. It is unfortunate, however, that she does not bring out the bearing of Eaton's botanical and geologic work upon the research of his own day, and upon the development of American science. His influence upon teaching is indicated much more clearly.

Still more unfortunate is Miss McAllister's fondness for what once was called "elegant" writing—the kind Eaton himself avoided. Thus she begins the chapter on family life by comparing Eaton to a diamond in the rough, while his business career is "like a strange interlude." The founding of the Rensselaer School is introduced by paragraph which tells us that *perhaps* Eaton reviewed his past achievements during a fever, feared that they were futile, and so conceived this new project which would endure.

Well, *perhaps* he did. But Miss McAllister has given other and better reasons why Eaton should have planned a school supported by his friend and patron. Her speculation is not in keeping with her subject, who seems to have been endowed with a quite unfevered perception of his own abilities, his influence, and the job he could best perform for science in an unscientific time.—CARROLL LANE FENTON.

THE FOUNDATIONS OF CONSERVATION EDUCATION. Edited by Henry B. Ward, Chairman and Editor, Committee on Conservation Education. Education in Conservation, Pamphlet No. 3, vi+242. 12 plates. The National Wildlife Federation, Washington, 1941. Paper 60 cents; buckram $1.

In the past the problems of conservation have never been fully appreciated until a crisis is faced, then enough of the public may become interested to demand or sponsor

legislation or other action to avert impending disaster to our natural resources. The effectiveness of such last-minute or deathbed interest in our resources can never approach the value of a public fully informed of conditions and looking ahead toward the avoidance of catastrophe before the full symptoms of destruction have set in. Only through education is such an attitude possible for in the heat of final action on conservation measures there is very commonly revealed a lack of sincerity and of consistency when conflicting interests are aired. When a government bribes farmers to restrict their production of agricultural commodities in the name of a planned national economy and simultaneously allocates hundreds of millions of dollars to create irrigation projects, one of whose objectives is to make new lands available for production of crops, the average, intelligent citizen finds himself in a quandary as to the distinctions between honest conservation and crooked politics. For, as Dr. Pack has so aptly expressed it, both of these plans "cannot be right at the same time." A full-blown contention between conservation and other interests leaves the citizen somewhat confused as to the side he should support. Divorced from the heat of contention between conflicting political and economic interests, conservation as a principle has values that are readily instilled into the open mind. But the place and time for such an education is not in the smoke and mud of an open conflict. Rather, the foundation of conservation education lies in the training of minds open to the facts and natural laws fundamental to effective conservation.

Obviously the logical place to allocate a program of conservation education is in the educational system. Unfortunately the principles and values of conservation have been sadly neglected in the curriculum, apparently because there has been no clearly defined conviction of where such instruction can be best allocated.

The National Wildlife Federation, through its Committee on Conservation Education, is carrying on a study of the educational aspects of conservation and this committee is making a significant contribution to the clarification of the problems through a series of publications. The current contribution, which forms the basis for this review, is a book entitled "The Foundations of Conservation Education." In this volume there is much excellent material for the use of teachers and several articles are so clearly, so directly, and so attractively written that public school pupils would read them with pleasure and profit. Throughout most of the book emphasis is placed upon the fact that the approach to an understanding of conservation is closely integrated with the materials of the life sciences (page 139, *et seq.*) and that "the problems of conservation are not entirely biological, but their foundation rests on life."

Lack of integration of the science program in the varied levels of the school system is decried and in this lack is pointed out the weakness of failing to consider organisms as living things for only in such light is biology fundamentally related to conservation. While the series of essays included in this book contains a wealth of inspiring material on conservation it seems to the reviewer that a closer integration of the series of independent articles would have made them of greater value. Only the unusual science teacher, already overburdened, will make the effort to incorporate new materials into his teaching. Just so long as conservation and its works are intimately associated with politics it will be difficult for even the sincerely interested science teacher to differentiate between conservation and other things masquerading under the guise of that name. The present volume fearlessly discloses some of these situations and will give the teacher a clearer concept of the relations of conservation to science.

Until the content of the biological courses becomes more wisely stabilized and the importance of conservation instruction becomes more generally appreciated, the present volume offers some of the best material that can be placed in the hands of the teachers and pupils. It will doubtless serve as an important factor in hastening the proper recognition of conservation as a subject for instruction in the schools.

From the varied view points, two of the chapters has distinctive merit as embodying materials that would be of living interest to high school pupils. These are the chapter on "The ABC of Conservation" by Dr. Paul B. Sears and one on "The Pitfalls of Conservation" by Dr. Arthur N. Pack. Some of the other chapters have more distinctive value to the teacher in providing historical background of the problems of teaching and of other aspects of conservation outside the immediate field of biology.—H. J. VAN CLEAVE, University of Illinois.

THE SOILS THAT SUPPORT US. By Charles E. Kellogg. The Macmillan Company, New York, 1941. xiv + 370 pp., 79 figs. $3.50.

Soil is part of the mantle rock. Yet it also is a complex system of inorganic, dead and living materials which changes and renews itself according to its environment as well as its constituents.

This is Dr. Kellogg's major thesis in his long-awaited popular guide to the young science of pedology. The book begins with a short history of soil studies, in which due credit is given to Russian pioneers. It then deals with such subjects as organisms, profiles, effects of surface and ground water, and the great soil groups. Emphasis constantly is placed on the environment, whose effects may be far more important than those of the mineral matter of which the soil first was composed.

Use and care of the soil, as well as erosion, receive eight chapters. They close on a note of optimism, for Dr. Kellogg believes that democratic political and economic institutions will combine with wise treatment of the environment to bring a "secure future for both soil and people." This belief seems to be based largely on hope, however, for Dr. Kellogg does not show that wise use of the surroundings is now practiced or widely desired by man.

The Soils That Support Us is well-planned, comprehensive and authentic—but it also is rather dull. Dr. Kellogg devotes much space to the terminology of soil science, but omits the illustrative detail which would make results as well as processes real to his lay readers. He does not attempt the vivid, swift-moving style which distinguishes many publications of the Soil Conservation Service, nor does his book have their wealth of dramatic pictures. Even though his purpose is to inform rather than persuade, it seems that he might well have borrowed some of the methods which the SCS has used with obviously good effect.—CARROLL LANE FENTON.

CRATER LAKE, THE STORY OF ITS ORIGIN. By Howel Williams. University of California Press, Berkeley, 1941. xii + 97 pp. 10 plates. $1.75.

Five years have passed since Smith and Swartzlow seriously questioned collapse and advocated explosion as cause of the caldera which now contains Crater Lake. During that time Dr. Williams has restudied the field evidence. After issuing a technical report on calderas in general, he now presents his conclusions in popular form.

Dr. Williams finds that Mount Mazama, whose remains enclose the Crater Lake caldera, reached a height of almost 12,000 feet during Pleistocene times. Glaciers spread at least 17 miles from its summit, but melted to lengths of 3 or 4 miles. Then came explosive eruptions, which blew 5 cubic miles of material from the volcano in the form of pumice and enclosed crystals, and shattered 1.5 cubic miles of the solidified cone. After an interval, these eruptions were followed by hot blasts and avalanches of tremendous scope.

Still, only 6.5 cubic miles of material had been blown out; 17 cubic miles must have been removed to destroy Mount Mazama. Dr. Williams believes that this was accomplished by subterranean drainage of magma, producing a void into which the crater collapsed. This may have happened about 5,000 years ago—Oregon already was inhabited by Indians when the explosions occurred. Still later, eruptions of dark lava covered the caldera floor and built the small cone called Wizard Island.

Dr. Williams has divided his book into two parts: a narrative history of Mount Mazama, and a presentation of evidence. The latter contains abundant data presented in the form of dialogue and arranged to guide the visitor who wants to see the essential features of Crater Lake and the region around it. The first part, however, will make the visitor want to see them, for it is a story told with the vividness and incisive speed inherent in the destruction of Mount Mazama itself. Dr. Williams feels his subject as well as he knows it, and in these 36 pages he has produced one of the most dramatic and convincing pieces in the popular literature of geology.

—CARROLL LANE FENTON.